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Proceedings of the
CONFERENCE
OF
DIRECTORS AND COLLABORATORS OF SOUTHERN AGRICULTURAL EXPERIMENT STATIONS ON EXPORT POSSIBILITIES FOR SOUTHERN AGRICULTURAL PRODUCTS

Held at New Orleans, La.
March 30 and 31, 1967

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

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FOREWORD

The Conference on Export-Possibilities for Southern Agricultural Products was held on March 30 and 31, 1967, in New Orleans, La. This conference was sponsored by the Southern Utilization Research and Development Division in cooperation with the Southern Agricultural Experiment Stations. Its purpose was to strengthen liaison between the Southern Utilization Research and Development Division and the Experiment Stations, and to exchange information on important subjects of joint interest.

This publication reports the statements presented by the various speakers during the conference.

Underscored numbers in parentheses refer to literature cited by the author. The references, figures, and tables are reproduced essentially as they were supplied by the writer of each paper.

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PROCEEDINGS OF THE CONFERENCE OF DIRECTORS AND COLLABORATORS OF SOUTHERN AGRICULTURAL EXPERIMENT STATIONS ON EXPORT POSSIBILITIES FOR SOUTHERN AGRICULTURAL PRODUCTS, HELD AT NEW ORLEANS, LA., MARCH 30 and 31, 1967

FIRST SESSION: B. H. Wojcik, Southern Utilization Research and Development Division, General Chairman

WELCOME

by

C. H. Fisher, Director
Southern Utilization Research
and Development Division

It is a pleasure to welcome all of you--old friends and new--to the 1967 Conference of Collaborators of Southern Agricultural Experiment Stations.

If there is anything normal or usual about our Collaborators' Conference, it is that the State Directors are usually not present. Therefore, I am grateful that several State Directors, other administrators, and special speakers are here to make important contributions to the Conference.

There has always been cooperation among the States, USDA, and industry in agricultural research, and this cooperation is growing. In support of this statement, I wish to cite the long-range study, "A National Program of Research for Agriculture", prepared jointly by the States and USDA with some aid from industry. It is pertinent also that a joint States-USDA task group has been established to review and plan the overall cotton research program of the States and USDA.

Our annual conferences with the State Collaborators represent another means of cooperation among the States, USDA, and other organizations. In planning these conferences we try to follow a pattern or formula that will provide the best conferences possible. We shall appreciate receiving advice and suggestions that will help improve the Conferences.

The Southern Utilization Research and Development Division (SURDD) holds several Conferences during the year that might be of interest to our colleagues in the State Stations. For example, we review progress in Oilseed research at our annual Cottonseed Processing Clinic, which is sponsored jointly by the Mississippi Valley Oilseed Processing Association and the Southern Utilization Research and Development Division. Cotton research is reviewed annually at our Cotton Utilization Research Conferences. The Seventh Cotton Utilization Research Conference will be held April 26 to 28 at the Roosevelt Hotel in New Orleans. We cordially invite representatives of the State Stations, universities, and industry to participate in our annual conferences.

The subject of our Conference is appropriate and timely because exports are becoming increasingly attractive as a profitable outlet for farm crops.

Exports have long been major outlets for some important Southern crops[1][2]. In 1860, cotton accounted for more than half the Nation's total exports valued at $400 million. Before World War I, we usually exported about 66 percent of our cotton crop. In the period 1926 to 1930, we exported 59 percent of it[2]. A much smaller percentage of the crop is exported today.

Frank Barlow, in his address, will tell us that exports represent a large and growing market for farm products. We can plan our processing and utilization research to strengthen our competitive position in the export market. We can direct our research also in other directions to increase the utilization of farm crops. The objectives would be:

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[1] Askew, W. R. The rice picture. U.S. Consumer and Mktg. Serv. Agr. Situation 51(3): 4–5. 1967.

[2] Cohn, D. L. The life and times of King Cotton 286 pp., illus. New York.

1. To increase per capita consumption of food.

2. To increase consumption of animal products, etc., which have high acreage and calorie requirements.

3. To increase industrial utilization of farm crops.

4. To decrease dependence on imports.

5. Increased exports.

Let's look again at these several research objectives. What are some of their characteristics and advantages?

1. Increased per capita consumption of food based on the development of products of increased attractiveness (tasty, attractive texture and appearance, nutritious, convenient-to-use, and low-cost). It is admittedly difficult to effect increases in per capita food consumption. The demand for food products is relatively inelastic in the domestic market, and the increased consumption of one food product may displace another. Nevertheless, an increase of only 1 percent would increase food sales at the farm level by many millions of dollars. It has been reported that food consumption increased 2.5 percent per capita from 1957 to 1959 to 1966[3]

2. Increased consumption of animal and similar products that represent inefficient use, calorie-wise, of land. A 1 percent increase in livestock production will increase feed use equivalent to 80.5 million bushels of corn[4]

Over the past 15 years the amount of beef and veal consumed annually by the average American has increased about 40 pounds--a gain of almost two-thirds. This increase in per capita consumption coupled with our population growth has so expanded markets that beef production has doubled since the early 1950's[4].

3. Increased industrial utilization of farm crops. This route is attractive in that the actual and potential markets are large[4] and success would be achieved by competing with petroleum, natural gas, and other non-agricultural raw materials. The competing raw materials, however, are inexpensive and vigorous research on their behalf is conducted on a large scale.

4. Decreased dependence on imports. Relatively little research has been done to replace imported materials with domestic products. Such research could be directed toward growing the imported materials in the U. S. (mainland or offshore) or manufacturing the desired end products from crops grown domestically.

5. Increased exports. There are export possibilities not only for food products, but also for industrial products and technical know-how. In 1965, the U. S. imported knowledge and technical know-how to the extent of $577 million and paid $63 million for imported knowledge. This provided an excess of exported knowledge over imports amounting to $514 million[5]

While considering export possibilities, it is only prudent to consider total world needs for food. Let's look first at the food requirements of our own country. An insight into the expected demands on American agriculture by 1980 is furnished by a long-range study recently completed by the Department and the Association of State Universities and Land-Grant Colleges[6]

This study indicates that the domestic demand for farm products will increase by a third in the next 15 years. The United States will have about a fourth more people to feed in 1980 than it had in 1964. Americans will have more money to spend on food and other products, because the disposal income per person is expected to rise more than 40 percent[5]

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[3] United States Department of Agriculture. Background on farm and food prices, U.S. Dept. Agr. Unnumb. Pub., 8 pp. 1967.

[4] United States Agricultural Research Service. Strengthening research on utilization of agricultural commodities. A Report to the Congress of the United States in Response to Senate Resolution 415, U.S. Dept. Agr. Unnumb. Pub., 56 pp. 1963.

[5] United States Department of Commerce. Technological innovation: Its environment and management. 83 pp. Washington D.C. 1967.

[6] Schnittker, J. A [Under Secretary, U.S. Dept. Agr.] . Address at Houston, Tex., March 14, 1967

Our future food needs, though, are dwarfed by those of less-fortunate peoples. The basic problem can be stated simply. World food supply is increasing at an average rate of 1 percent a year, but world population is growing by more than 1.8 percent a year. If these trends should continue until the year 2000, an average of only 1,340 calories a day... starvation level... would be available to each person.

The productivity of our farms must increase at least 2.1 to 2.2 percent each year to meet the domestic and export demands expected by 1980. This means stepping up the rate of growth, which has remained virtually unchanged at 1.9 percent a year since 1950[6]

The year.since our last Collaborators' Conference has been busy and eventful. Aaron M. Altschul has occupied two positions until recently, namely, that of Chief of the Seed Protein Pioneering Research Laboratory and Special Assistant to the Secretary of Agriculture for expanding supplies of protein-rich foods to meet world needs. The Washington job is so important, and Dr. Altschul's contributions to it have been so great, that Secretary Freeman asked him to move to Washington in order to give all his energies to the world food problem. The transfer of Dr. Altschul represents a loss, of course, for the Southern Utilization Research and Development Division but a gain for the world food program. We are proud of Aaron and wish him every success in his new and important work.

Those of you who have recently looked at the southern side of our Laboratory have probably noticed the construction of a new building. This new building, which should be ready for use next September, will house two pilot plants for processing cotton. One of the pilot plants will process cotton mechanically, whereas the other will be used for the chemical or wet processing of cotton. We are looking forward to having these new facilities because they will increase our potential for doing research helpful to cotton and to cottonseed.

I would like to express appreciation to everyone--chairmen, speakers, and visitors--for contributing to the success of this Conference. I wish to give special thanks to Louis Hawkins, Research Coordinator of the Southern Stations for his interesting and informative talk entitled, "Research in the South, Teamwork Fashion."

RESPONSE

by
Doyle Chambers, Director
Louisiana State University
Agricultural Experiment Station
Baton Rouge

The subject of this conference is of interest to the South as you indicated, and I believe it is more particularly so for Louisiana. The three major farm commodities of this State depend to a great extent on foreign markets--cotton, rice, and soybeans. Perhaps you did not know that Louisiana is in the soybean business. It is the No. 1 crop--acreage now--looks like a million and a quarter acres for 1967, and I won't be surprised at 2 million acres within a short time. These are largely exported as beans from this State. Again on behalf of the directors and the collaborators from the States, Dr. Fisher, we thank you for this opportunity to participate in this program.

USDA AND THE GROWING WORLD FOOD CRISIS

by
F. R. Senti
Deputy Administrator
Agricultural Research Service, USDA
Washington, D. C.

The precarious state of the world food supply is today a subject of the gravest concern. The problem of getting enough to eat is nothing new, of course. Droughts, floods, pests, and diseases have periodically decimated crops and livestock and brought hunger and sometimes famine. Nevertheless, nations have managed to supply enough food to support moderately growing numbers of people.

What concerns us today, however, is the fact that the rate of population growth is rapidly exceeding the rate of increase in food production. The added fact that population growth is greatest in parts of the world where food production is lowest emphasizes the gravity of the situation.

As you know, the United States is fully committed to a policy of helping the free nations of the world achieve greater self-sufficiency in producing food. Many public and private agencies throughout the country are contributing to this effort. The land-grant schools have been especially effective in their team approach to problems of research and education in the less developing areas.

Within the framework of the total national effort, then, I would like to discuss briefly the role of the U. S. Department of Agriculture in coping with the growing world food crisis.

Food for Peace

The basic legislation authorizing the Department to conduct its food aid programs is the Agricultural Trade Development and Assistance Act of 1954, known as Public Law 480. Congress in 1966 extended the legislation for another 2 years--1967 and 1968. The new and amended effort is based on the Food for Peace approach.

The legislation has four parts:

Title I authorizes sales of U. S. farm products for local currencies and for dollar credits.

Title II authorizes famine relief and donations of food on a government-to-government basis and through voluntary organizations.

Title III authorizes barter of U. S. farm products for materials and service from abroad.

Title IV stipulates that the program will be used to help those friendly countries that seriously try to cope with their own problems of food and population. It also provides criteria for determining the selection of commodities to be used in this program.

The most significant feature of this new legislation is the insistence upon self-help efforts to accelerate food production within the food-short nations themselves. This approach recognizes the fact that transferring food from the developed to the less developed regions cannot possibly solve the world food crisis. . . that only by a determination to help themselves can nations ever hope to produce enough food for their people.

These nations are expected to undertake some practical measures, such as constructing adequate storage facilities; improving marketing and distribution systems; teaching farmers proper methods and techniques; and devoting land resources to the production of needed food rather than nonfood crops, particularly those in world surplus.

Moreover, they are expected to take steps to limit their run-away population growth. The new food aid bill authorizes, on request, the use of foreign currencies from export sales to support programs of family planning.

Another aspect of the legislation is that U. S. farm products need no longer be in surplus before they can be shipped to a food-short nation. Instead, products that are requested and determined "available" by the Secretary will be shipped. Obviously, U. S. supplies will not be reduced below the amounts needed for domestic consumption, adequate carryover, and anticipated commercial exports. Production of sufficient farm commodities to meet all our commitments will be included in the Nation's overall agricultural production planning.

The new food aid plan seeks to speed up still further the progress of countries from "aid" to "trade" status. This transition will be helped by making available long-term credit for dollars, thus making it easier to purchase U. S. farm products on the commercial market.

As the less developing nations build their food production capacity, the United States will gain from the increased buying power that inevitably follows. A USDA study shows that as incomes of foreign consumers go up, their purchases of U. S. farm products increase twice as fast. Our continued economic development depends in large measure on the rate of economic growth in these nations.

The foreign currencies that accrue from sales of U. S. commodities will continue to be used in these countries, as before, for a number of useful purposes. These include market development, loans to U. S. and foreign business firms, foreign economic development, payment of U. S. expenses abroad, family planning, international educational and cultural exchanges, sales to tourists, and--of particular interest to the Department's Agricultural Research Service--research.

P. L. 480 Research

Most of the research that ARS sponsors abroad under Title I of P. L. 480 is basic. The philosophy underlying this work is that it must be mutually beneficial to the United States and to the countries where it is done. We have been fortunate in attracting top-level scientists, including, in at least one case, a Nobel prize winner. The work has been highly productive and beneficial to our agriculture. Because of the largely basic nature of the work, it has considerable application to the worldwide problems of increasing food production. As of December 1966, we had 578 projects underway in 29 countries.

In Israel, for example, scientists have found outstanding sources of genes for high protein content in oats, along with resistance to rust and other improved qualities.

Collections of the wild oat Avena sterilis were found to have an unusually high protein content--over 10 percent--higher than the best we have in the United States. The outlook for transferring this high-protein character to our cultivated varieties is encouraging, and research to achieve that objective has already been started. Oats are not well adapted for growing in tropical parts of India, Africa, and Latin America. However, it should be possible to improve their adaptability through breeding by adding disease resistance, nonsensitivity to day length, and better agronomic characters, such as short stature, stiff straw, and greater response to fertilizer.

Another important feature of Food for Peace is the emphasis on nutrition, particularly for children. We can now enrich commodities to improve their nutritional value. We are emphasizing programs to fight malnutrition in children through school lunches and preschool feeding. Nutritionally adequate prepared food mixes designed to meet serious protein and vitamin deficiencies are getting more attention. Nutritionally valuable foods that were not previously available because they were not in surplus can now be made available.

The new legislation also provides for greater emphasis on an international effort to modernize agriculture. As part of this effort, United States is supporting the expansion of organizations such as the Food and Agriculture Organization of the United Nations. It is working for closer and more effective coordination of food aid with other economic assistance programs. And, it is becoming increasingly involved in technical assistance and training programs for those nations that need it.

USDA AID-Sponsored Help

The Department of Agriculture is one of many government and private agencies working to help develop these nations. Its technical assistance and training programs are financed by the Agency for International Development, and coordinated and administered by the USDA's International Agricultural Development Service. This agency was set up in 1963 especially for this purpose. It is financed by AID and staffed with USDA personnel.

Our responsibilities in this worldwide effort are twofold: (1) To help the developing nations build the research, education, credit, cooperatives, and other institutions needed for modern farming and (2) to train the future agricultural leaders and administrators of those countries.

Requests for USDA assistance range from highly detailed scientific requests to calls for assistance in broad agricultural planning and execution. The International Agricultural Development Service, along with other USDA agencies, evaluates the requests and determines how the Department can provide the most effective help.

Projects are conducted under a Participating Agency Service Agreement (PASA). Department employees remain on the rosters of their own agencies and receive administrative supervision and technical assistance from them.

USDA's involvement in these programs has expanded considerably. During fiscal year 1966, for example, 300 of our technicians were working in 84 international development projects in 39 countries. About half of these technicians were members of resident teams assigned to work in a particular country for 2 or more years. There are 23 of these long-term resident teams. Most of the technicians working abroad are from the Agricultural Research Service, with 18 other Department agencies also represented.

As of June 30, 1966, AID had committed over $500 million specifically for agricultural development in the poorer nations. USDA is conducting AID-financed programs totaling $6. 1 million.

A strong part of our technical assistance is the growing effort to train specialists from the less developed nations. These specialists are given the training they will need to supervise vital government agricultural programs in their own countries. The training ranges from specific work in a particular field, such as soils, crops, irrigation, or livestock, to more general work in administration, management, communication, and development.

In fiscal year 1966, more than 3, 400 individuals received at least part of their training under programs arranged by USDA, and 1, 300 received all of their training under these programs. As you know, extensive training is also provided by the land-grant institutions, private foundations, and numerous commercial firms.

You may be interested in some of the work the Department is doing in the developing nations. Let's turn first to research.

AID-Sponsored USDA Research

USDA, African, and Asian scientists have gotten some rather productive research underway. In one project centered in Nigeria, Kenya, and Uganda, they have succeeded in developing a maize hybrid that yields from 50 to 75 percent more than the local varieties. The acreage planted to hybrids increased from 400 acres in 1963, when they were first planted, to 120, 000 in 1966, with the possibility of nearly a half million acres this year. The hybrids are being accepted by the small-scale native farmers as well as the large-scale operator.

This development involved the very close cooperation of numerous agencies, including a seed company in Kenya. Seed was sold under a combination deal; the purchaser of a bag of seed was required to buy fertilizer in the recommended amount and to follow certain prescribed cultural practices. As a result of this combined approach, the better farmers are achieving yields ranging up to 143 bushels per acre.

A cooperative project on pulse crops was recently initiated in Asia with headquarters at research centers in Iran and India. Thousands of strains of pulse crops collected from all parts of the world are now being tested for productivity, adaptation, disease and insect resistance, and nutritional quality. Some strains have been found to yield 40 percent more than local varieties; others, 20 percent more.

These foods are an important source of nutrients to the people of the Near East and Middle East and South Asia. We expect that the work will help the villagers in these areas to grow enough food to meet their needs and increase the quality of their diets.

In both these major projects in Africa and in Asia, as well as in all our other work, we are trying not only to develop improved varieties and cultural and management practices, but also to train technicians and scientists who can eventually continue the work for their own countries.

USDA and African research teams have made good progress in their attempts to control contagious bovine pleuropneumonia. This is a lung disease that kills from 10 to 70 percent of the cattle herds of the protein-hungry nations of Africa each year. The recovered carriers are capable of causing new outbreaks up to 3 years later. Scientific teams in Kenya are developing an improved diagnostic tool for identifying the healthy-looking carriers, as well as a vaccine to protect cattle against the disease. Much of this work on the basic nature of diseases of the lungs may well have application to human medicine.

In another part of Africa, research teams are trying to determine the most effective way they can utilize the sterilization technique to eradicate the tsetse fly. At least 23 varieties of this pest spread death and disease throughout Africa, and large areas cannot support domestic food-producing animals, except poultry, because of it. British and African scientists, as well as the Agricultural Research Council of Central Africa, are cooperating in this work. As you know, the sterilization techniques has been successfully used to eradicate the screwworm livestock pest from the United States.

High-Protein Foods

On another front, the Department of Agriculture is contributing to the development of new protein foods and protein-enriched foods.

Recent achievements in the protein enrichment field include a process for making protein-rich soybean flour with inexpensive hand-operated equipment; ways to produce high-protein flour for bread and soup mixes from flour mill byproducts now going into livestock feeds; a method of preparing tempeh, a staple Indonesian food, from cereals and cereal-soybean mixtures; and development of a protein-rich vegetable mixture of chickpeas and sesame and soybean flours.

The high-lysine corn developed at Purdue may have potential for supplying more protein to food-short nations. Scientists at Purdue are also working on an AID contract to find ways of improving the protein quality and content of sorghum, a cereal widely used in developing countries.

USDA is planning to test artificial supplementation of wheat with lysine as a simple and cheap way of improving world protein resources. USDA has also contracted with a private firm to find rapid and accurate ways of analyzing amino acids in soybeans to speed breeding programs for high-protein soybeans.

These are only a few of the many protein development projects underway throughout the country, just as research is only one of the many aspects of our technical assistance abroad.

Other Assistance

In Latin America, USDA's largest technical assistance effort is in Brazil. We have 22 specialists there working on price stabilization, cooperatives, marketing economics, marketing and storage facilities, market news, and credit, as well as research. Soil scientists are assisting the Government in locating 75 million acres of land in the western two-thirds of the country suitable for resettlement from the overpopulated sections. Late in 1966, 15 Brazilian officials studied farm price, grain storage, and marketing programs in the United States under a program arranged by USDA. Brazilians have also had U. S. training in livestock production and disease control, and food distribution.

Other major USDA projects in Latin America are in El Salvador, Nicaragua, the Dominican Republic, Colombia, Ecuador, Bolivia, Paraguay, and Guatemala.

In Asia, famine-threatened India and war-torn Vietnam as well as Nepal, Thailand,

and Jordan are receiving USDA technical assistance. Last November, the Department signed an agreement to conduct a major part of the AID agricultural assistance program in South Vietnam. Five USDA teams will eventually include 90 men in agricultural credit and cooperatives, irrigation and rural engineering, plant and seed multiplication, forestry, and provincial agricultural advisers.

In Africa, USDA is assiting Nigeria, Tunisia, Kenya, Liberia, and Ethiopia with the development of their agriculture. A new supervised credit program is being established in Nigeria, for example, as part of that country's plans to modernize its agriculture. Some 84 Nigerian agriculturists recently trained in the United States have returned to their homeland to assist farmers in applying improved techniques on crops, livestock, and management. Our economists are helping Kenya with agricultural policies to help that country achieve a hoped-for 6.8 percent annual increase in production.

How significant is all this work, one may justifiably ask, and how optimistic can we be about the outcome?

We believe this cooperative agricultural development work in the developing nations is significant. For the first time, we now have a concerted, planned, and organized approach to the problems that need to be met. We no longer approach the difficulties of building a nation's agriculture on a piecemeal basis, where the work itself may be excellent, but lost in its overall contribution to the economy. We are now pinpointing the needs of these nations and seeking solutions that best fit into the framework of their needs and special way of life.

It is possible, I believe, for the poorly developed nations to modernize their agriculture and produce enough food for their people. Whether or not they will, however, still remains to be seen. There are some hopeful signs.

One encouraging sign is that increasing numbers of leaders in these nations are beginning to recognize the seriousness of their chronic food shortages and the need for action.

Another hopeful sign is the increased willingness of these nations to help themselves. The expressed readiness of many populations to learn how to limit their numbers is an example. The proven willingness of native farmers to accept newer methods, if they see they are profitable, is another. Given the tools and the magic of incentive, there is almost no limit to what individuals can do to help themselves--and their countries.

And finally, the steadily increasing flow of all kinds of new ideas and knowledge into these less developed nations, along with the hopes they carry for a better life, is bound to bring about change.

TAILORING FOOD PROPERTIES TO MEET EXPORT REQUIREMENTS

by

W. D. Powrie
University of Wisconsin, Madison

For survival, primitive man was dependent on the skills of collecting fruits and vegetables, and killing animals. The pangs of hunger drove him to travel hundreds of miles in the search for food. His diet changed with the geographical locality and the season of the year. In times of famine, primal man was forced to draw on the fat reserves of his body; and over a prolonged period of undernourishment, he died from the lack of sufficient nutrients.

One of the most important advancements of mankind was the switch from food hunting to food production. Studies have indicated that man in the areas of Iran and Iraq started to cultivate the soil and domesticate animals around 5000 to 6000 B. C. With the abundance of food in these areas, more time was available for the development of speech, skills, imagination, and patience. All of these abilities were contributors to a civilized life. However, all was not sweet.

Some groups of mankind had, at times, agricultural hardships such as crop failure or loss of domesticated animals by disease. Wars and revolutions were caused by lack of food in specific villages. Transport of surplus food was difficult in those early times although elementary methods of food distribution to needy people were developed. Since those early food-producing times, man has progressively learned new techniques for optimizing crop production and animal husbandry. Even with malnutrition and disease, population growth has not ceased in the so-called less-developed areas of the world. Around 1800, the population of the world was about 1 billion. By 1960, the world population increased to around 3 billion. Without any unforseen widespread world war, about 6 billion people will reside on our world by the year 2000 (8, 10, 11). Since 1938, the major increase in world population has been attributed to births in the less-developed countries.

At present, the supply of food is inadequate in many countries throughout the world. In North America, a surplus of food has accumulated because of advanced technology of farming. Shortage of food in some less-developed countries is caused by lack of arable land, insufficient fertilizer, primitive cultural practices, inadequate rainfall, and food consumption by wildlife, such as rodents. With a large labor force on the farms, industrialization in the poverty-stricken areas has been restricted, and thus cash payment for large amounts of surplus crops from other parts of the world is prohibitive. If the economic structure of the developing countries could be raised by industrialization, the American food industry could enter into a vigorous, widespread export of new food products.

A few large food companies have become involved in the manufacture of low-priced protein supplements. For example, the Quaker Oats Company has set up five plants in Latin America to manufacture Incaparina, a mixture of cottonseed, sorghum, and corn flours with about 28 percent protein. This dry powder may be used for the preparation of a variety of South American food choices such as soup, colada, a drink called refresco, or baby food. To obtain consumer acceptability and repeat sales, governmental cooperation along with educational programs to point out the values and uses of Incaparina was essential. The Incaparina program was directed primarily towards the low income families. The families are unable to purchase expensive food with a high nutritive value. With the availability of a versatile plant protein supplement such as Incaparina, the protein malnutrition of children of poverty-stricken families should be nullified.

Man, regardless of religious taboos, geographical location, and environmental conditions, has three basic physiological needs for food. These requirements are adequate supply of (1) carbohydrates to satisfy hunger and provide energy for the body, (2) water to relieve thirst, and (3) nutrients to prevent malnutrition. Generally speaking, adequate water supply is not a problem in the less-developed countries. Deprivation of food will lead to a physiological imbalance with the activation of specific drives such as hunger and thirst. The term "physiological drive" refers to the physiological condition which drives or forces man into activity. When hunger arises, man becomes restless and hyperactive and indeed has an intense urge to seek food. However, with starvation for several days, the hunger pangs of man may become less intense. Evidence has indicated that blood sugar plays an important role in the onset of hunger. According to Mayer (7), the difference between the sugar levels in the venous and arterial blood controls the degree of hunger. Apparently, receptors in the hypothalamus are capable of detecting the difference in glucose concentrations between the venous and arterial blood. Hypothalamic lesions in humans have been the cause of abnormal obesity due to excessive eating of food. In the case of a normal person, just a carbohydrate diet would be sufficient to satisfy the hunger drive, because food carbohydrates can be readily digested and absorbed with the result of increased glucose in venous blood. The people in the less-developed countries ingest food which is high in carbohydrates, particularly starch. In all probability, hunger per se is not the critical factor in the lives of the majority of people in the less-developed countries even though the slogan "freedom from hunger" frequently confronts us. More important is the consequence of malnutrition due to lack of essential nutrients, such as proteins and vitamins.

Man must ingest food to provide body energy for voluntary body movement, involuntary muscle motion of the organs, and production of heat energy for maintenance of body temperature. A lack of calories in the diet along with insufficient high quality protein may cause a disease called marasma. This disease is most common in children below 1 year of age. The energy value of food is measured in terms of calories. For example, for every gram of carbohydrate, four calories of energy can be obtained for body utilization. For minimum survival at rest, the energy requirement is roughly 1,500 calories per day. However, for normal body movement in 1 day, the basic survival energy value must be raised appreciably. When energy intake in the form of food constituents falls below the minimum survival value, man cannot perform manual duties such as ploughing and cutting grain stocks with a sickle, and indeed he will lose weight and become ill. The Food and Agricultural Organization (UN) has adopted a caloric scale based on a reference man, weighing 65 kilograms, having an age of 25 years, and living in an area with an average environmental temperature of 10° C (8). With a normal day's activity, his caloric requirement was assigned as 3,200 calories. Pawley (9) suggested a minimum caloric intake of 2,400 per person per day. On the average, the caloric value of a man in a less-developed country is between about 2,000 to 2,500 calories (4, 9). The average caloric supply per capita per day in the Far East and Latin America has been estimated to be around 2,050 and 2,450 calories, respectively. The person in the Near East has an average caloric supply of about 2,450 calories. If the minimum caloric intake for man is assigned as 2,400 calories, then, on the whole, the people in the less-developed countries are on a minimal calorie diet yet are not truly suffering from extensive hunger pangs. In the developed countries of Europe, North America, and Oceania, the average caloric content of food has been estimated to be around 2,900 calories. Certainly, on an individual basis, the caloric demand will be dependent on weight, age, sex, environmental conditions, and physical activity of the person.

Cereals are the major sources (about 60 to 70 percent) of calories for people in Mediterranean and Asian countries (5). For example, Indians obtain about 65 percent of their total calorie intake from cereals such as rice, wheat, sorghum, and millet. Wheat is the major cereal produced and eaten in the Mediterranean zone (5). On the other hand, the Far Eastern countries have populations that strongly favor rice as a staple food along with small amounts of wheat and corn. Wheat, rice, and corn are excellent sources of carbohydrates other than crude fiber. Wheat and corn contain about 70 percent digestible carbohydrates, most of which is in the form of starch. An estimated carbohydrate content of unpolished rice is 76 percent.

The protein contents of rice, corn, and wheat are around 7, 9, and 12 percent, respectively. The biological value of rice is fairly high, around 72, while corn and wheat have biological values of about 42 and 59, respectively. The low biological values of proteins in these creals can be attributed mainly to the lack of some essential amino acids. The first limiting amino acid of wheat protein is lysine, while rice and corn are deficient in tryptophane. Children with diets containing low quality protein will be unable to utilize the amino acids effectively, and as a consequence, physical and psychomotor development will be retarded, and body disorders will appear. Protein malnutrition in children leads to a deficiency disease called kwashiorkor. Widespread occurrence of kwashiorkor is evident in less-developed countries because of the deficiency of high quality protein. Animal products with high quality proteins are expensive, sometimes unavailable or prohibited by religious taboo. People in less-developed countries consume about 9 grams of animal protein per day per person, while the average consumption in Europe and North America is about five times higher. The challenge of the food scientist is to formulate low-priced palatable and nutritious foods for peoples of the emerging nations.

Educated or uneducated, starving or well-fed, man has a desire to enjoy food. When pleasant sensations are perceived by an individual during visual examination of the food, smelling, and mastication, then the food is considered to be palatable and acceptable. The degree of pleasantness derived from the consumption of a food is dependent on the attributes of the food itself, past experience related to food, physical state of the person (hungry), environmental factors, and taboos. From the standpoint of food, the structural properties (physical stimuli) and chemical compounds (chemical stimuli) will elicit numerous responses governed by the activation of receptors in the mouth, nasal passage, and ears. Any drastic change in the stimuli of a food may cause rejection due to lack of identification of the product or actual dislike for some strong flavor notes (i. e. , peppery, sourness).

The food habit of an individual is the sum of his food choices. The monotony of food consumption is overcome, even in poverty-stricken families, by the serving of a wide variety of food choices. The preferences for specific foods are acquired during childhood when adult foods are introduced into the diet. Through a conditioned response mechanism, the growing child recognizes and accepts specific familiar foods. Within a short period after weaning, children acquire a food habit with the inclusion of familiar foods. A new food item with no similarity to the familiar food choices may be rejected completely. Thus, the critical examination of food habits within areas of a less-developed country must be initiated before any discussion of the development of a nutritious food product.

Generalizations must be developed from detailed data on food habits. For example, a wide variety of stews are consumed by tropical Africans with preferences ranging from clear, seasoned stew to those with peppers, tomatoes, onions, and fish (1). A generalization may be made that a protein-containing liquid is the base from which a variety of stews can be prepared. If one were concerned about the protein inadequacy of the people, a plant protein supplement could perhaps be marketed as a stew ingredient. The addition of flavoring compounds and coloring matter may provide a sales appeal without increasing appreciably the cost of the protein supplement.

In many developing countries, dietary patterns are closely linked with religious beliefs, social obligations, or values and legends. According to Blair (1), every aspect of an African's life is related to food. Some food will keep an unfriendly spirit away, while other foods may cause volunerability to evil powers. In a number of African cultures, it is a common belief that milk causes sterility in women, speckled bananas cause smallpox and fish causes leprosy when eaten. Obviously, such taboos may be responsible for protein malnutrition. An intimate understanding of food taboos in less-developed regions is a prerequisite to the successful fabrication of a new food product.

Consideration of the typical consumer must not be overlooked in the planning stage. The food preferences and demands of the rural farmers and urban folk in the same country may be tremendously different. With the dependency of urban dwellers on retail outlets for food, new food products may be readily accepted whereas farmers may have an adequate supply of staple foods from their fields and would have no concern for new food products regardless of their nutritional benefits. Certainly, special formulations and processing techniques would be required, if the consumers were to be infants. With no teeth, mastication of textured food by an infant would be impossible. Before full-scale production of a food item, test-marketing along with educational programs should be undertaken to be assured of overall acceptability of the selected consumer group (2, 6).

Since protein deficiency is predominant throughout all developing nations, American food manufacturerers who are interested in introducing low cost, processed food into deprived areas must select high quality plant byproducts with large amounts of proteins. The oilseed flours, such as cottonseed, peanut, and soybean, contain appreciable amounts of proteins. For example, a cottonseed flour contains about 50 percent protein. The biological values of some oilseed proteins are moderately high. A combination of oilseed flours provides a high quality protein source with a good balance of essential amino acids. Satisfactory protein foods can be prepared by the addition of limiting amino acids to an oilseed flour. This amino acid supplementation method may be valuable when the synthetic amino acids are low in cost.

In summary, we might say then that the basic purpose of introducing new food supplements or fabricated foods into deprived countries is to improve the nutritional standards of both children and adults. Before introducing a new food supplement or a fabricated food, the consumer must first of all be chosen, the food habits must be evaluated, the chemical, physical, and organoleptic analysis must be carried out on the native foods, and finally prestige must be placed on the food supplement or the fabricated foods.

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EXPORT POSSIBILITIES FOR AGRICULTURAL COMMODITIES

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My purpose here is to project the export possibilities for agricultural commodities. How can we best do this? I suggest we identify and examine the trends of the pertinent facts involved. By laying the various sets of facts and trends one upon the other, we paint an overall picture from which you develop perspective to see for yourself what to expect in the future. What are these pertinent facts?

First, let us review major commodity world trade trends and how the United States has shared in this trend. Then let us take a look at global shifts in world trade patterns and world price movements. I would also like to review very briefly the barriers to trade expansion and current trade policies. Finally, let us review the growth in U. S. agricultural exports and consider the long-range and immediate export prospects for the major commodities.

World Trade Trends and the U. S. Share

This Nation's agriculture has an important stake in foreign trade. This has been true since early Colonial days, but since World War II our involvement in foreign economic development throughout the world has made U. S. agriculture a vital factor in world stability. Before World War II, our agricultural exports were dominated by cotton and tobacco, commodities with a regional flavor, primarily of interest to the South. Since World War II, however, growth and change in foreign demand have called for more U. S. wheat, rice, feed grains, oilseeds, and the products thereof, livestock products and a long list of other specialty products. This has generated a general and growing awareness of the international scene by farmers, businessmen, and the distributors of agricultural products in all of our 50 States.

The expansion in world trade since 1950 has surpassed all expectations. World trade in cereals was just slightly greater than the pre-World War II levels of some 40 million tons in the early 1950's, but by 1966 it had nearly tripled, reaching 114 million tons (fig. 1). Leading the way were feed grains and wheat with a threefold increase from 38 million tons annually to some 107 million tons over this 15-year span. Rice trade, however, is still below prewar levels and in 1966 accounted for only about 6 percent of total world trade in cereals (table 1). World trade in cotton has increased approximately 50 percent over prewar levels, while tobacco trade has increased about 80 percent. Soybeans and soybean products, of course, have had the most spectacular relative increase. Prewar trade was small and was largely accounted for by exports from China. Today, world net trade of soybeans is nearly 7 million tons, soybean oil about 600,000 tons, and soybean meal about 2.5 million tons. The United States is now the principal supplier.

Since World War II, the U. S. share of this expansion in world agricultural trade has increased substantially for each of the commodity groups included in table 1, with the exceptions of cotton and tobacco. The U. S. share of wheat and flour exports increased from 9 percent of the world total in 1935-39 to 39 percent in 1966, while feed grains increased from 9 to 60 percent and rice from 1 to 18 percent. U. S. exports of soybeans and soybean products, which were not even on the board before World War II, now account for 87 percent of world exports. In contrast, the U. S. share of cotton exports has declined from about one-half of the world total during the period 1935-39 to about one-fourth in recent years, and tobacco from some 40 percent to 25 to 30 percent.

Commodity Composition of U. S. Exports

To get a view of the current commodity composition of U. S. agricultural exports, let

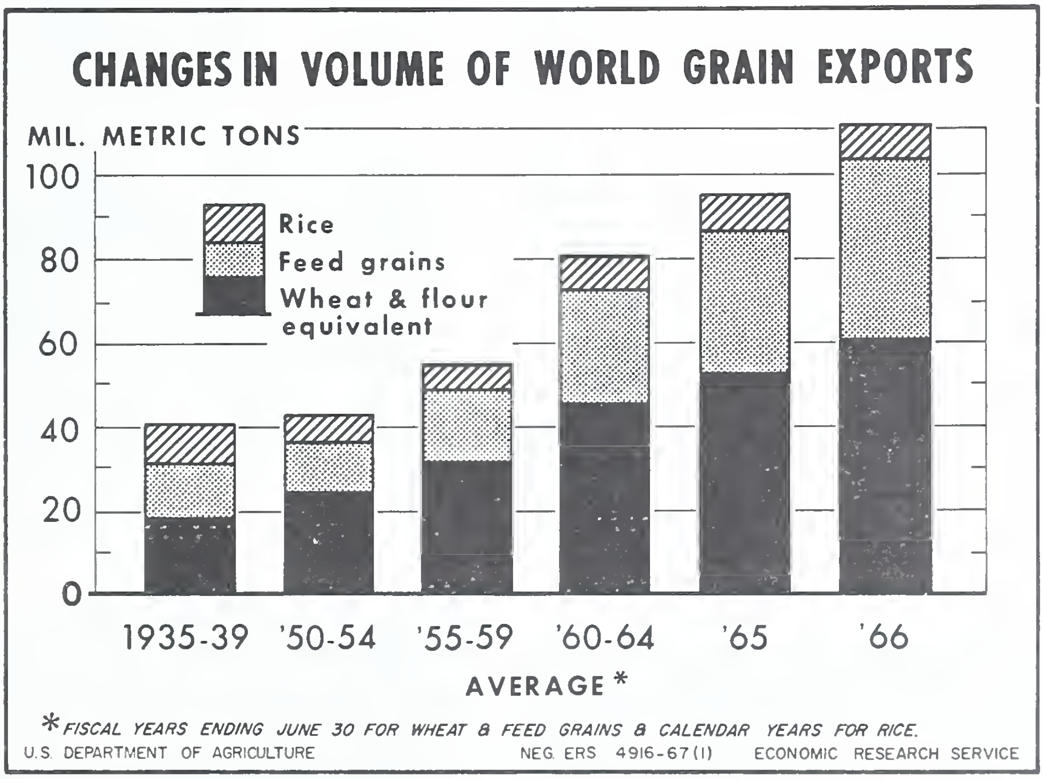


Figure 1

Table 1.--Volume of world exports, for major commodities, by crop year [1]

Commodity	Average 1935-39	Average 1952-54	1964	1965	Preliminary 1966
	Million metric tons				
All cereals					
United States	2.8	14.2	42.0	39.1	50.4
Rest of world	37.3	31.0	57.5	56.1	63.9
Total world	40.1	45.2	99.5	95.2	114.3
U.S. as a percent of total	7	31	42	41	44
Wheat and flour equivalent					
United States	1.5	9.3	23.1	19.6	23.6
Rest of world	15.9	17.3	33.4	31.6	38.7
Total world	17.4	26.6	56.5	51.2	62.3
U.S. as a percent of total	9	35	41	38	38
Feed grains [2]					
United States	1.2	4.2	17.5	18.1	25.4
Rest of world	12.4	9.5	18.4	18.4	19.6
Total world	13.6	13.7	35.9	36.5	45.0
U.S. as a percent of total	9	31	49	51	56
Rice					
United States	0.1	0.7	1.4	1.4	1.4
Rest of world	9.0	4.2	5.7	6.1	5.6
Total world	9.1	4.9	7.1	7.5	7.0
U.S. as a percent of total	1	14	20	18	20
Cotton	Million bales				
United States	7	4 [3]	4	3	5
Rest of world	6	8 [3]	13	14	13
Total world	13	12 [3]	17	17	18
U.S. as a percent of total	54	33	24	18	28
Tobacco	Million lb.				
United States	421	474 [3]	515	468	551
Rest of world	615	777 [3]	1,365	1,360	1,224
Total world	1,036	1,251 [3]	1,880	1,828	1,775
U.S. as a percent of total	41	38	27	26	31
Soybeans and oil equivalent [4]	Thousand metric tons				
United States	n.a.	248 [3]	1,629	1,669	1,618
Rest of world	n.a.	119 [3]	98	127	242
Total world	n.a.	367 [3]	1,727	1,796	1,680
U.S. as a percent of total	n.a.	67	94	93	87

[1] Source.

[2] All figures for feed grains are fiscal year.

[3] 1950-54 average.

[4] Data for soybeans and soybean oil are on a calendar year basis.

us take a look at figure 2. Wheat, feed grains, and oilseed product exports each exceeded $1 billion in 1966. Animal and meat products and fruits and vegetables now outrank cotton and tobacco in terms of value. It should be noted, however, that cotton exports in 1965-66 were well below normal and nearly 40 percent below the level expected in the current year.

Major Geographic Shifts and Their Significance

Despite the recent export expansion in U.S. exports in commodities other than

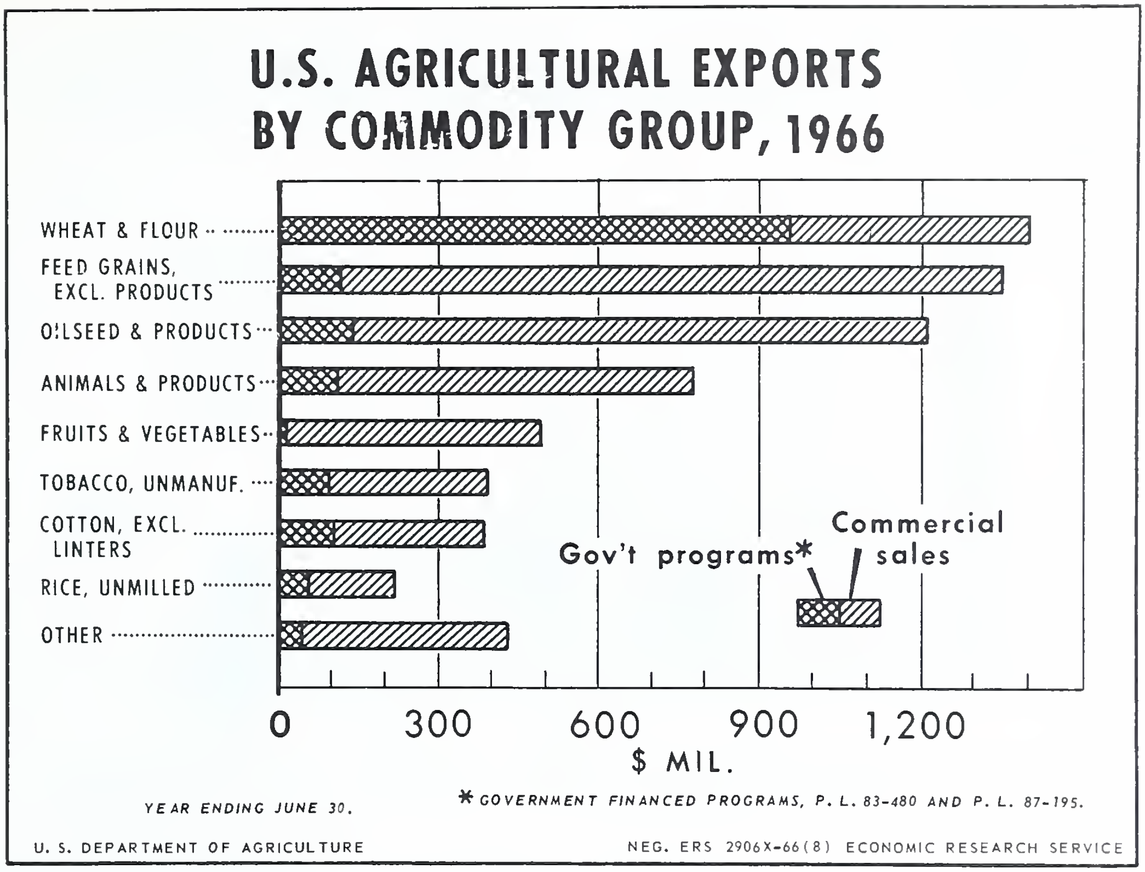


Figure 2

cotton and tobacco with a broad geographic interest, the Midsouth and the Gulf States have improved their No. 1 position as the gateway to foreign markets for agricultural exports (table 2). As the volume of wheat, rice, feed grains, and soybean exports increased from an average of 480 million bushels in 1950-55 to 2,075 million in 1965, the flow through Gulf ports increased from 43 percent to 63 percent of the total.

Significant geographic shifts have taken place in world agricultural trade since World War II (fig. 3). Before the war--1934-38--

Table 2. --Total U. S. grain exports, including soybeans, by port areas, 1950-66 [1]

Port areas	Average 1950-55	Average 1956-60	Average 1961-65	1965	1966
	Million bushels				
Gulf	205.8	413.5	876.6	1,046.5	1,304.9
Lake	17.1	72.2	232.8	295.3	300.4
Atlantic	161.5	207.2	170.1	161.6	191.6
Pacific	95.8	189.6	192.2	240.7	277.7
Total	480.2	882.5	1,471.7	1,744.1	2,074.6

[1] Source: U.S. Dept. Agr., Consumer Mktg. Serv., Grain Market News, Jan. 1967

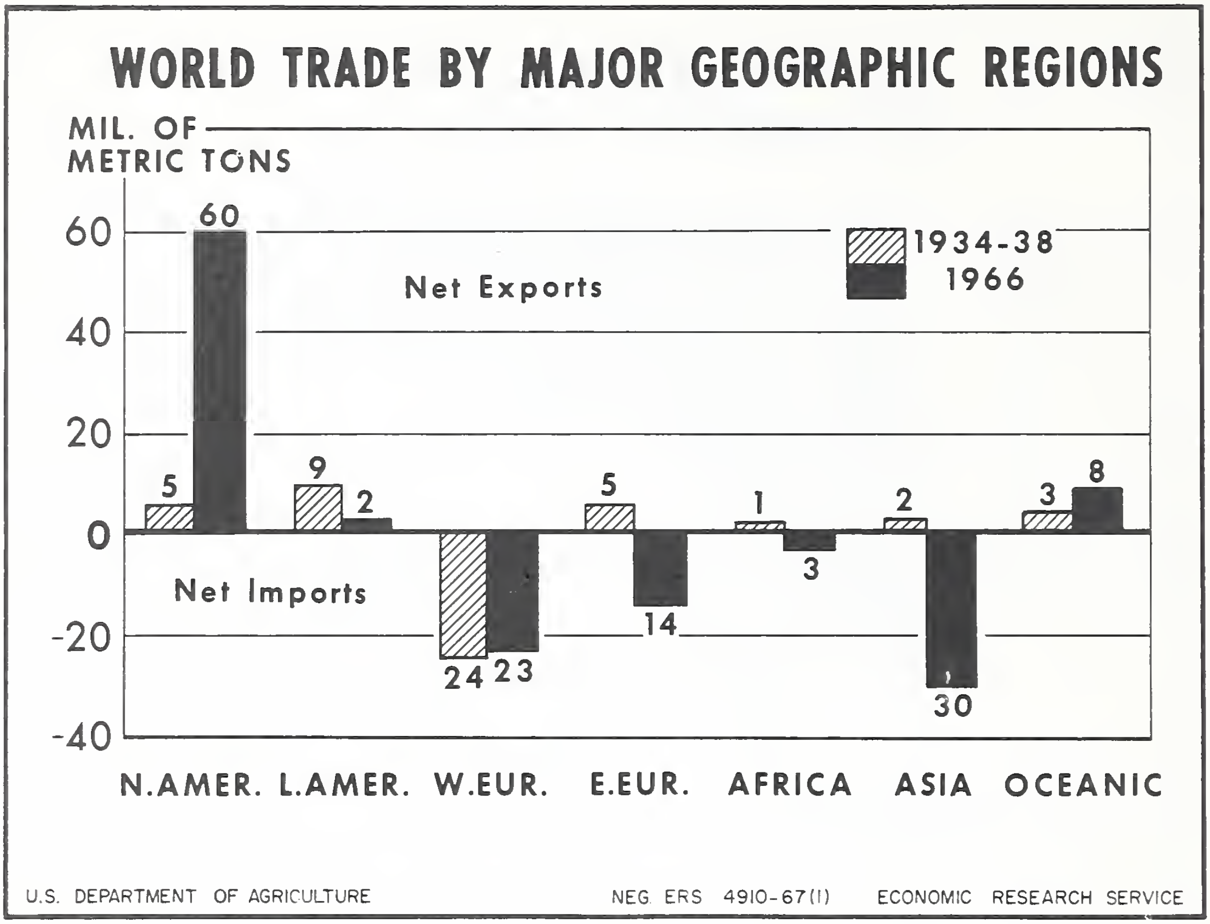


Figure 3

only Western Europe was a net importer of agricultural products. Latin America ranked first as a net exporting region, followed by Eastern Europe, North America, Oceania, Asia, and Africa, in that order. By 1966, North America was by far the major net exporting region of the world, accounting for some 85 percent of the total. Oceania's exports have also increased, but Latin America has just managed to maintain its position as a net exporter, a level of approximately $2 billion in 1966.

Western Europe has maintained its prewar position as a net importing region of about $23 billion annually, but significant trends in population growth and agricultural production in Asia, Eastern Europe, and Africa have shifted these areas of the world from net exporters to net importers. Asia represents the biggest change from a net exporter of $2 billion prewar to a net importer of $30 billion in 1966. These shifts are indicative of the growing dependence of the rest of the world on the North American continent and Oceania for agricultural imports.

The geographic shifts in world agricultural commodity trade are very significant to U. S. agriculture. The large increase in soybean imports has been concentrated in the commercial markets of Western Europe and Canada where they have more than doubled (fig 4). The large increases in feed grain imports have also been concentrated in the commercial markets of the industrial countries. The outlook for commercial sales to Western Europe and Japan is favorable. But the indications are that future import needs of the developing countries are also increasing. Fulfilling these later needs, however, is dependent on concessional terms because the less-developed countries are unable to earn enough foreign exchange from their own exports to meet increasing food import needs or the capital imports needed for development.

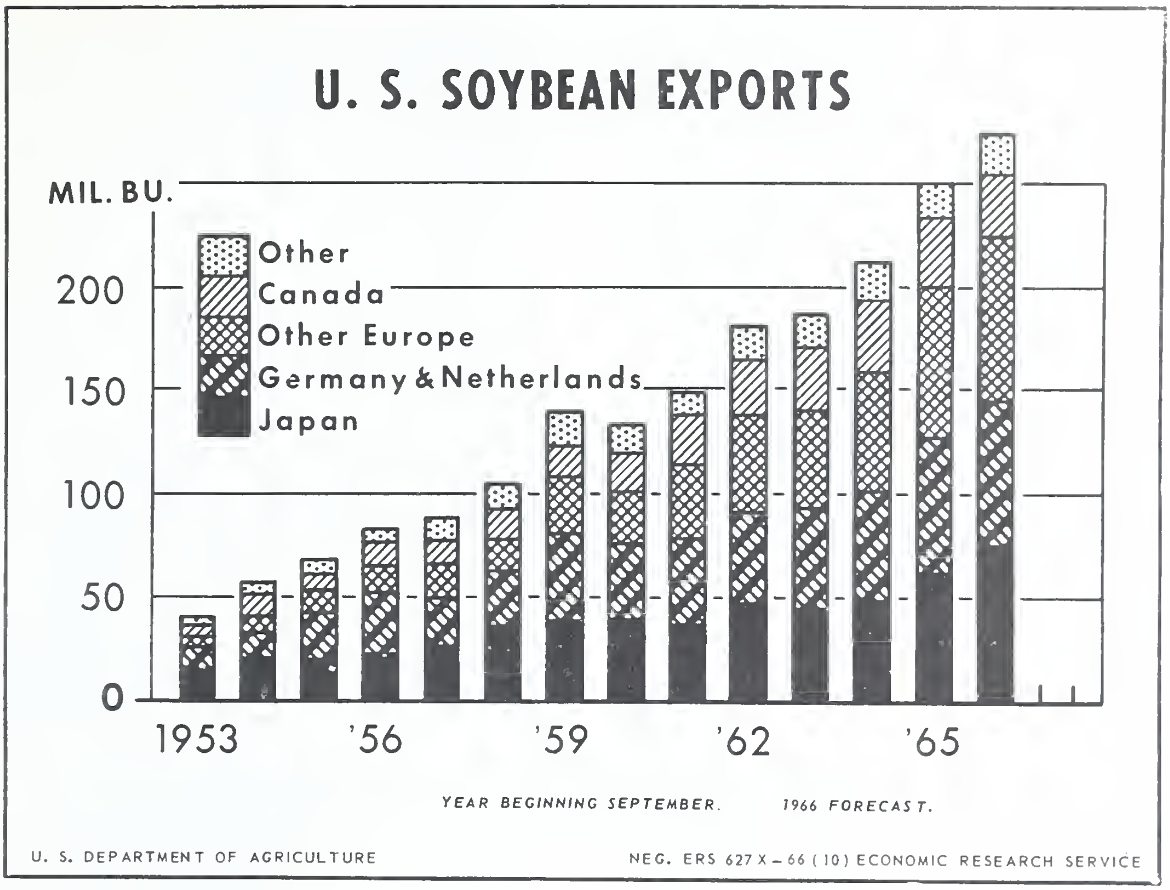


Figure 4

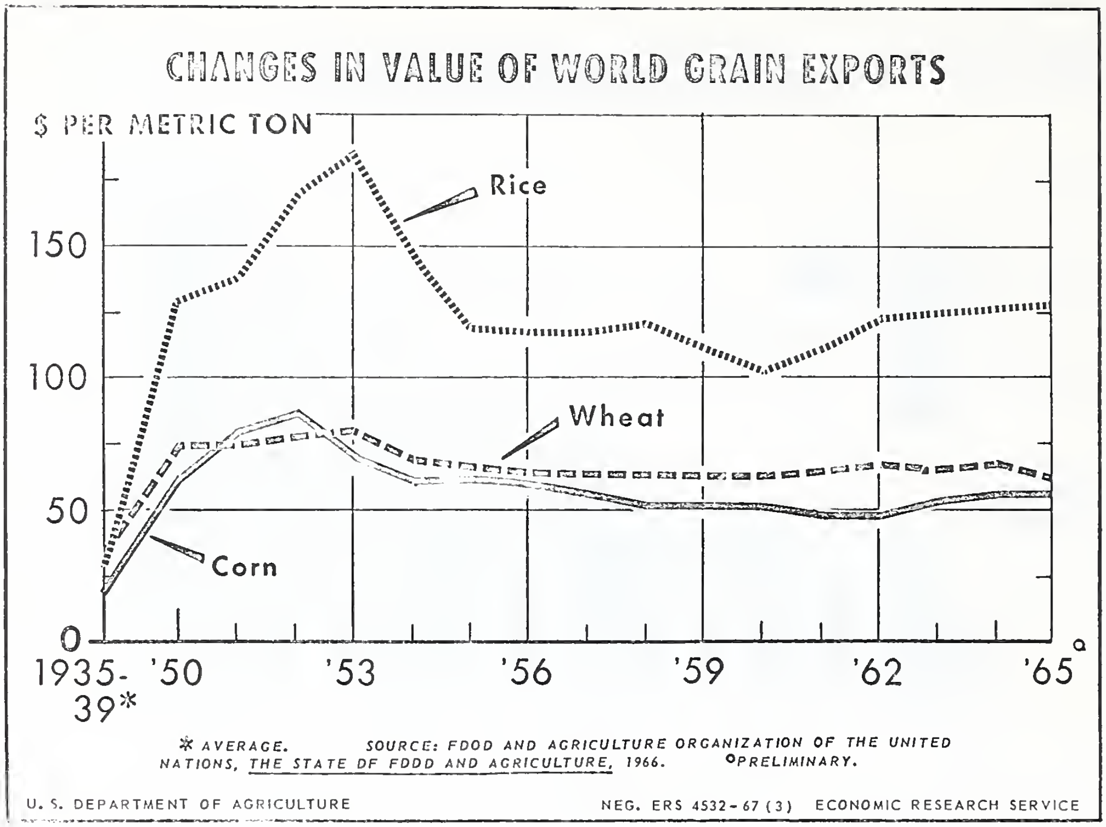
Geographic shifts in world agricultural imports have been brought about by population growth, rising incomes, economic development, low price elasticity of demand for food grains in Western Europe, and high income elasticity for feed grains in Western Europe and for food grains in the developing countries. Increased grain imports by developing countries have been made possible by concessional exports under Public Law 480 and other concessional food aid programs.

It is difficult to say when agricultural development will expand enough in the vast underutilized land areas of Latin America and Africa for them to participate more actively in supplying the developed countries of Europe and Japan and the less-developed countries of Asia. So the immediate future growth in world agricultural commodity trade will depend largely on the ability of the United States, Canada, Australia, Argentina, South Africa, and other traditional exporting countries to supply the commodities needed to meet the increasing demands for food and fiber.

Significance of World Price Movements

Figure 5 illustrates how world grain price movements have passed through three major phases since World War II: (1) From 1945-52, aggregate grain prices rose as a result of scarce supplies and urgent needs for emergency relief and rehabilitation following World War II and strong world demand during the Korean War; (2) from 1953-56, average prices of all grains declined as a result of partial recovery of production in some countries and the scarcity of foreign exchange in others; and (3) from 1957-65, prices have remained relatively stable.

Price movements of soybeans, meal, and oil have shown less stability since 1955 than



* AVERAGE. SOURCE: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, THE STATE OF FOOD AND AGRICULTURE, 1966. °PRELIMINARY.

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Figure 5

those for wheat, rice, and the feed grains (table 3). The general price declines in 1958-60 were followed by rising prices in 1961, which continue to show the growing strength of the foreign demand for meal over oil. As new highs are being reached in meal prices, oil prices have failed to reach mid-1950 levels.

Table 3. --Price movement of soybeans on world market[1]

Calendar year	Soybean[2]	Soybean oil[3]	Soybean meal[4]
	- -Dollars per metric ton - -		
1955	111.0	299.3	102.3
1956	116.0	343.6	98.5
1957	106.0	316.6	89.9
1958	94.6	260.3	93.8
1959	93.6	232.2	94.6
1960	91.9	223.6	90.6
1961	110.4	287.1	99.6
1962	100.6	227.5	105.8
1963	110.2	223.0	112.8
1964	110.8	229.9	112.3
1965	116.6	279.8	115.6

[1] Source: U.S. Dept. Agr., Foreign Agr. Serv.
[2] American, No. 2, yellow.
[3] American, degummed, bulk.
[4] Canadian, 45 percent protein.

World cotton prices declined drastically after 1950-51; but, since 1955, they have been relatively stable with a downward trend.[1] World tobacco price trends have been stable but upward. Export prices of U. S. flue-cured tobacco, which is of particular importance to the United States, have been rising steadily since the early 1950's, from 63 cents a pound in 1950-54 to 85 cents a pound in 1965, which indicates a rather strong demand.[2]

What are the relationships of world price trends to the expansion of trade? There are powerful advocates that price is everything--that low or declining prices are a stimulus to exports and rising prices a deterrent. It is pertinent to observe that the volume of trade in the cereal grains more than doubled from an average of 48 million tons in 1955-56 to 114 million tons in 1966 during a period of rather stable or slightly rising world prices.

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[1] Cotton—World Statistics, with supplements. International Cotton Advisory Committee, Washington, D.C. April 1963.
[2] U.S. Dept. Agr., Foreign Agr. Serv., Tobacco Division.

World trade in cotton continues to rise slowly. There is no clear evidence that the level of prices since 1956 has been more important than world economic activity in determining the long-term trend in aggregate trade.[3] Despite the rising trend in tobacco prices over the past 10 to 12 years or the restrictions imposed on imports, the volume of world trade has continued to climb. Also, in the case of soybeans, the growth in export volume has continued even though prices have been rising since 1960. This indicates that demand and other factors often have had more important effects on the volume of trade for most commodities than the level of price per se.

Production, Consumption, and Trade Relationships[4]

The expansion of world consumption and trade in wheat and feed grains during the 1950's and prior to 1962 took place while world stocks were excessive.[5] The expansion since 1962 has been at the expense of world stocks as world consumption has tended to exceed production (fig 6). Improvement in the supply-demand balance for wheat in the last several years has resulted from the continued heavy shipments on concessional terms under P. L. 480 to the less-developed countries, strong commercial demand, including large purchases by the Sino-Soviet Bloc, and to production controls primarily in the United States. During the late 1950's, world feed grain production tended to outrun consumption and excessive stocks accumulated. However, in the last 4 or 5 years, improvement in the world supply-demand balance in feed grains has resulted from increased commercial demands in Europe and Japan since 1962, increased domestic usage, and to the acreage diversion programs in the United States. The combination of circumstances now in the picture indicate the desirability of increasing world grain production to provide the quantities needed to meet increasing world needs.

Since the mid-1950's, the demand for rice has tended to run ahead of export availabilities. This has pushed up world prices. Despite policies to achieve self-sufficiency and restrictions of imports by an increasing number of major rice importing countries, the outlook for reasonably high levels of demand appears good. The continued high rate of population increases in the rice-consuming countries and the production disruption caused by the war in Vietnam are bullish factors.

The persisting upward surge in oilseed and high-protein meal demand can be met only through increased world production. As of now, the United States appears to be the principal country with the available capacity to meet the increasing import demands.

A cycle of 5 years has been noted in the imbalance between world production and consumption of cotton.[6] After the serious shortages during the Korean War and the high prices of 1950-51, world production exceeded consumption until 1955-56 by 12 million bales, with most of the excess stock accumulation concentrated in the United States. From 1956 to 1961, it was the other way around--with consumption exceeding production by nearly 6 million bales over the 5-year period, and a reduction in U. S. stocks to workable levels.

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[3] Should world cotton prices get out of alignment with rayon staple fiber, in terms of price, quality, or end-use performance, there is a definite possibility of substituting one fiber for another. However, there is no indication that price disparity between cotton and rayon has existed over the past 8 years. The extent to which rayon synthetic fibers have displaced cotton in a growing number of end-use markets suggests that performance of particular fibers in end-use products is more important than the price of the raw material. This subject was discussed by the author in a talk entitled "Competitive Factors Affecting Fiber Utilization." Proceedings of the Southern Agricultural Experiment Station Collaborators Conference, New Orleans, La., March 17, 1958.

[4] Food and Agriculture Organization of the United Nations, Agricultural Commodity Projections for 1970, May 1962.

[5] It is important to note that the excess of world wheat supplies over consumption during the 1950's was due primarily to bumper crops in only two periods—1952-54 and again in 1958-59 This was discussed by the Ninth FAO Group on Grains entitled "Feasibility for International Action for Coarse Grains. May 1963.

[6] U.S. Foreign Agricultural Service. World Cotton Supply and Demand Situation and Outlook, U.S. Dept. Agr. Foreign Agr. Circ. FC 16—66, Nov. 1966; and In Cotton—World Statistics, International Cotton Advisory Committee, April 1963.

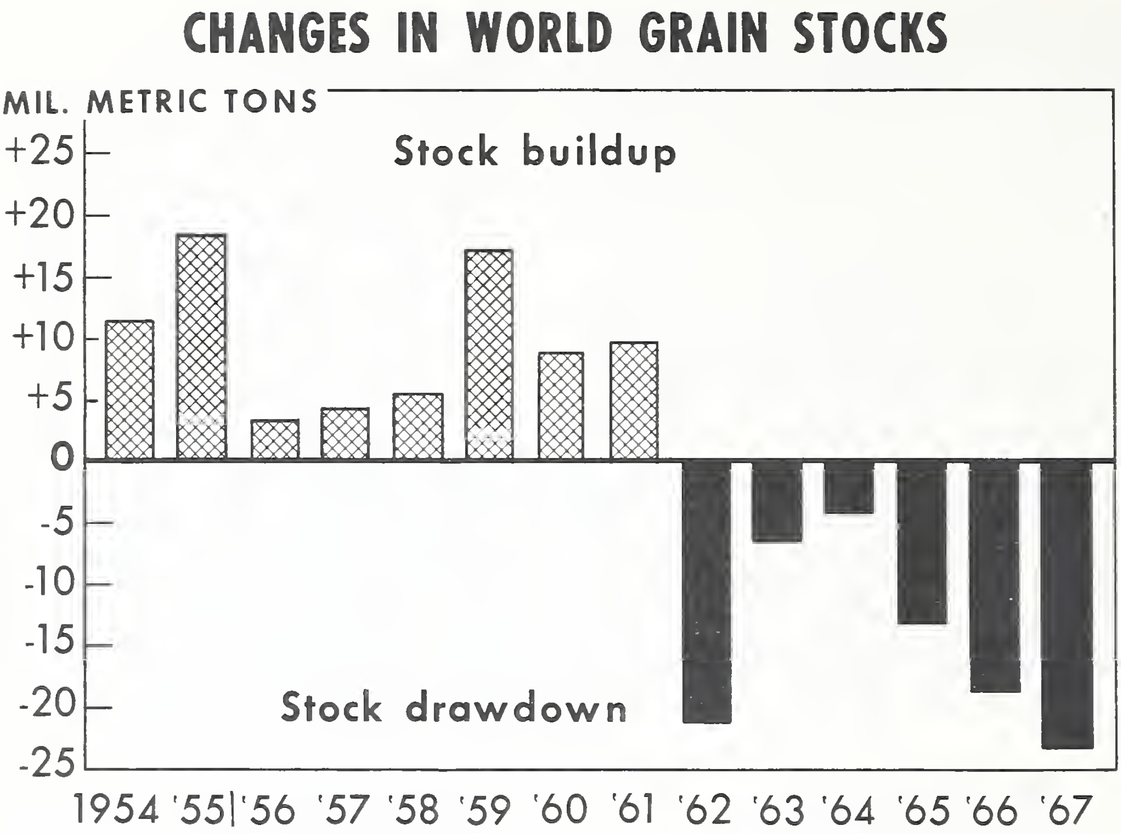

Figure 6

From 1962-66, world production again exceeded world consumption by 10 million bales. Most of this imbalance between world production and consumption was reflected in fluctuations of U. S. trade. And since the United States is the residual supplier, large stocks again accumulated in the Commodity Credit Corporation. By 1966-67, U. S. stocks reached an alltime high of 16. 8 million bales. Vigorous control programs instituted by the United States in 1966, together with a rise in world consumption and trade and a significant recovery of U. S. exports from 3 million bales in 1965-66 to over 5 million in 1966-67, have contributed to a reduction of stocks by some 5 million bales in the current year.[7] World stocks also are expected to decline from over 30 million bales in the past year to about 25 million bales this year--not greatly out of line with long run desirable levels.

In tobacco, there has not been too much imbalance between world production and consumption in recent years. Current U. S. stocks (2. 5 to 2. 8 year's supply) are only slightly above normal. This, together with the fairly stable carryover of the various types of tobacco stocks held by other countries and a high degree of governmental control over production and trade, insures against a significant imbalance between world production and consumption or extreme fluctuations in the volume of world trade from year to year.[8]

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[7] Even in the case of cotton, a commodity still in aggregate surplus, there is real concern over the shortage of medium to long staple of above average quality now becoming apparent in CCC inventories. The problem is that there is a high proportion of lower quality and short staple cotton in CCC inventory, especially after the large withdrawals of the longer staples and high qualities currently taking place. It is very important to have a balanced quality composition of current production and stocks in order to supply traditional customers with the grades and staple lengths required to meet mill requirements. This is very important in meeting both price and quality competition of rayon and the synthetic fibers. After considerable discussion within the U.S. cotton industry and Government, adjustments in quality premiums and discounts have been announced in the last 2 weeks to obtain better quality-staple length balance in stocks as well as in future production.

With the exception of cotton, we appear to be entering a period where surpluses no longer exist--certainly for wheat, feed grains, rice, soybeans, or livestock products. Even in the case of cotton, shortages of certain qualities and staple lengths are anticipated within the next year or so, and overall balance between world production and consumption does not appear to be far away. This means that future import requirements of most agricultural products must be filled from current production. Under such circumstances, a general strengthening in world prices is a distinct possibility.

Trade Barriers and Policy Issues

The growth in world wheat and feed grain trade and the significant expansion in the U. S. share of this trade since World War II occurred despite the import barriers imposed by the importing countries. The same is true for cotton, tobacco, and most other Temperate Zone commodities. As the volume of trade has grown over the past 30 years, free marketing of wheat, other grains, and most agricultural commodities in the classical sense has virtually disappeared. Today, international transactions and marketing are actively influenced or regulated by practically every country in the world. Complex systems of marketing, pricing, and trade regulations have been developed to protect domestic producers from external competition and to aid exporters in international competition. These national policies will continue to exert influence over the direction and future volume of international trade in agricultural products. The United States is working diligently to achieve reductions in trade barriers. It is our interest to achieve as much liberalization as possible. However, the restrictionist policies followed by the importing countries are not expected to reverse the basic factors giving rise to the growing gap between domestic agricultural production and national food requirements in the importing countries.

A review of price supports for wheat in 23 importing countries shows that the general level of producer support prices in most importing countries is much higher than in the exporting countries (fig 7). This partly because production is less efficient and more costly in the importing countries and partly because these countries want to be as self-sufficient as possible. Thus, higher producer prices are required to encourage indigenous production--either to increase the area in crops or to achieve more intensive application of modern production technology.

Under present pricing systems, consumers in the importing countries usually are not allowed to benefit from the lower level of world prices--thus the lower world prices are not allowed to influence domestic consumption to any great extent. Even in countries where governments have subsidized consumer prices, such as Yugoslavia, Chile, and Egypt where import prices have been greater than domestic prices, world-price levels are not allowed to influence national price policies or consumer demand. Since the price elasticity for wheat is relatively low and feed grains relatively high in the industrial countries, it is important to recognize this factor in appraising the future commercial trade prospects of the United States and third-country exporters.

The future volume as well as the future conditions under which future international transactions take place depends upon a number of issues that are currently being discussed. Some of these issues are not yet clear, because we do not know whether European Economic Community (EEC) and other major importers will make significant concessions on grains and other agricultural products in the Kennedy Round talks.

On the basis of the volume of imports and the levies assessed, it is estimated that in 1965, the EEC collected levies on wheat imports from the United States and other nonmember countries in the amount of about $275 million. On corn, barley, and oats, it is estimated that levy collections amounted to another $315 million. Levy assessments represent revenue to the Common Agricultural Guidance and Guaranty Fund, which is available to finance the costs of implementing the overall common agricultural policy agreed to by the EEC. In effect, the levy assess-

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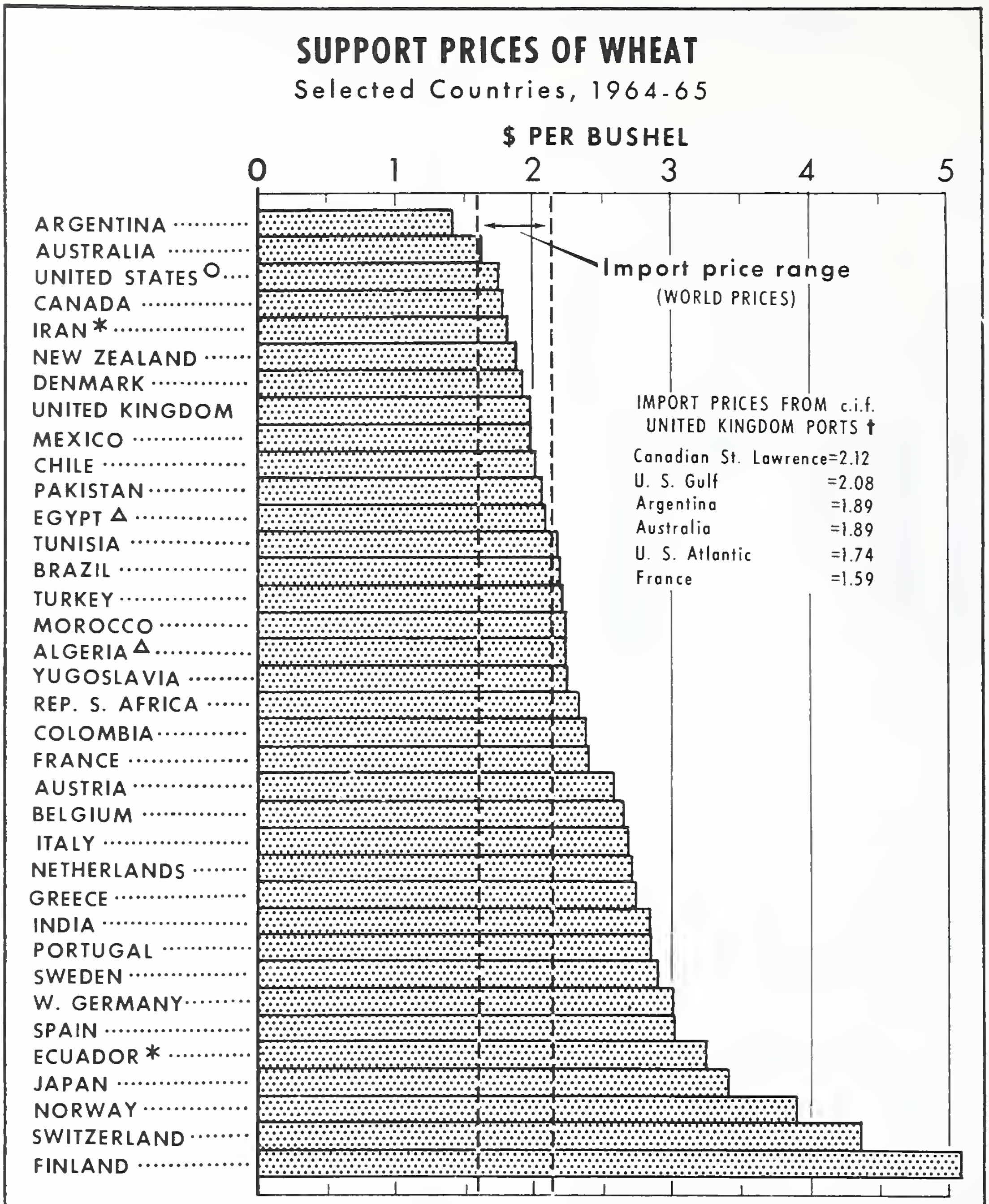
8/ U.S. Dept. Agr., Foreign Agr. Serv., Tobacco Division.



SUPPORT PRICES OF WHEAT
Selected Countries, 1964-65

○ WEIGHTED PRICE. TO THE BASIC SUPPORT OF $1.30 PER BUSHEL IS ADDED DOMESTIC CERTIFICATES OF $.70 FOR 45 PERCENT OF THE CROP CONSUMED DOMESTICALLY AND $.25 FOR THAT PART EXPORTED.

✱ 1963. △ 1961. † AVERAGE AUGUST - FEBRUARY.

SOURCE: INTERNATIONAL WHEAT COUNCIL, "WORLD WHEAT STATISTICS 1965."

U. S. DEPARTMENT AGRICULTURE NEG. ERS 4724-66 (8) ECONOMIC RESEARCH SERVICE

Figure 7

ments resemble a subsidy to the importing countries by the traditional exporting countries.

Factors such as these raise a host of questions that will be considered by the United States and other exporting countries, such as: To what extent do the objectives of domestic price policies in the importing countries differ from those of the United States and other exporting countries? Is there a basic conflict between the economic philosophy of the agricultural exporting and importing countries? Both follow policies to protect the incomes of domestic producers, but do the exporting countries assume more interplay between supply and demand factors than do the importing countries?

One of the big factors affecting the long-range outlook for export possibilities in agricultural products is economic development throughout the world. Development and growth are the keys to trade expansion. A recent USDA study illustrates how imports climb as incomes rise in the developing countries.[9] This study showed that imports of agricultural products on a commercial basis from the United States by the less-developed countries increased 12 percent for each 10 percent increase in per capita incomes from 1950-61 (fig 8). The implication of this relationship is that if per capita incomes could be increased by $100 a year in the developing countries, the demand for U. S. agricultural imports would increase about $0. 6 billion annually. This positive relationship between economic development and the expansion of agricultural trade gives the American farmer a special interest in our foreign aid programs, which are designed to help the underdeveloped countries raise their standard of living.

More rapid economic development in the less-developed countries would provide the opportunity for an expansion of the dollar export markets for U. S. agriculture. As these

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[9] Mackie, Arthur B. Foreign Economic Growth and Market Potentials for U.S. Agricultural Products, U.S. Dept. Agr., Econ. Res. Serv., FAER No. 24, April 1965.

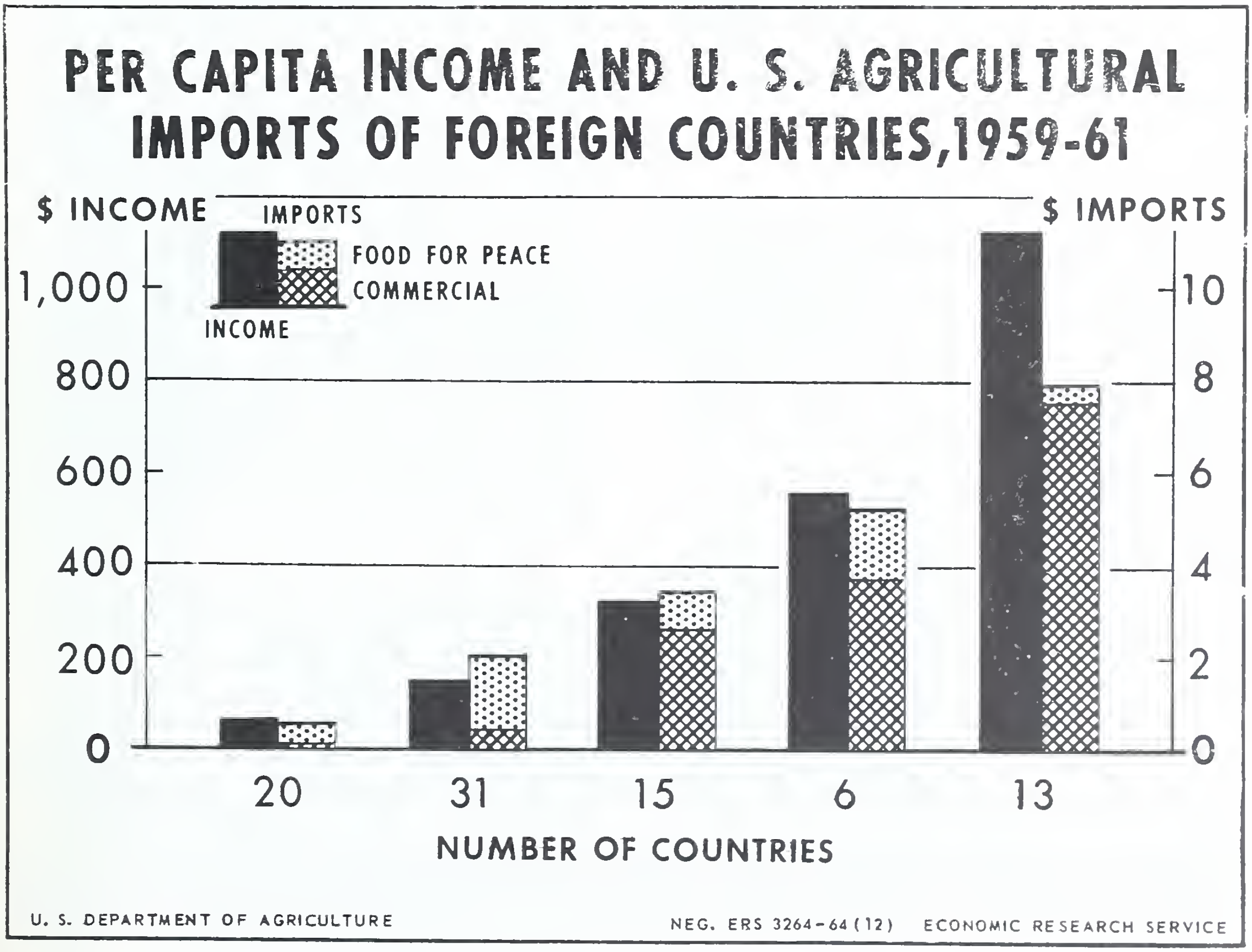

Figure 8

countries progress, they will be better able to finance commercial imports of agricultural products. Further, their food demands both in terms of volume and variety will expand rapidly. Comparative advantage probably will lead many of the tropical countries to increase their imports of many Temperate Zone agricultural products.

A recent study conducted by USDA has shown that by helping to promote economic development, the Food for Peace program also helped developed commercial markets for U. S. farm products.[10] In recent years, U. S. commercial sales of farm products have expanded considerably in four countries that were principal recipents under the aid program--Spain, Israel, Greece, and Taiwan. These countries have made significant gains in economic growth recently. Thus, they have increased their commercial purchase of agricultural commodities. Commercial sales of U. S. farm products to these four countries increased from an average of $21 million during the 1955-60 period to an average of $180 million in 1963-65.

Export Prospects

Just in the last 12 years, total U. S. agricultural exports have more than doubled--rising from $3. 1 billion in fiscal year 1955 to $6. 1 billion in 1965, $6. 7 billion in 1966, and an estimated $7 billion in 1967 (fig 9). There has been growth in every major commodity category except cotton. Last April, in Baton Rouge, the Administrator of the Economic Research Service observed that we can easily foresee an export level of $8. 0 billion or more by 1970.[11] What is not adequately recognized is that much of the recent export expansion has been for dollars (fig 10). Commercial exports in each of the last 3 years exceeded those of a decade ago by more than $2 billion. Currently, dollar sales are running at the rate of about $5. 1 billion annually. This expansion has been encouraged to a considerable extent by various types of export payments, but much of the recent expansion has been in categories not benefiting from export assistance. After an increase in concessional export programs in the late 1950's, exports under Public Law 480, the Food for Peace program, leveled off and since 1960 have averaged about $1. 6 billion annually. Figure 11 shows the principal recipients of U. S. agricultural exports.

Recent developments in the world supply and demand for grains and most other Temperate Zone agricultural commodities with the exception of cotton and tobacco indicate that we are moving into a period in which market forces will be far more important than at any time in the past 15 years. Already, strong demand for many commodities has made it desirable for the United States to ease restrictions on domestic output.

As surpluses disappear, many of our foreign customers are becoming concerned as it will become more difficult to obtain the specific qualities of the wheat they need at the prices they want to pay, thus requiring some adjustment in their procurement policies. Wheat reserves held by the principal exporting countries dropped from 59 million metric tons in 1961 to an estimated 31 million in 1966. Carryover in the United States in 1966 was below what many consider desirable if we are to exploit fully our commercial market opportunities and still meet our food aid commitments under the Food for Peace program. There are three important factors affecting the current wheat outlook: (1) The continuing large concessional shipments by the United States to India (an estimated 5. 0 million metric tons in 1966-67). (2) the substantial Canadian sales commitments to Russia and China in recent years [12], and (3) the prospects for 1967 harvests in the United States and other countries.

Under the flexibilities now built into our farm commodity programs, the Department on last August 8 raised the 1967 national wheat acreage allotment to 68 million acres, 16. 6 million acres above 1966. Feed grain programs have also been changed to encourage corn producers to increase acreages for the current year in an effort to meet increased domestic and foreign demand for feed and to

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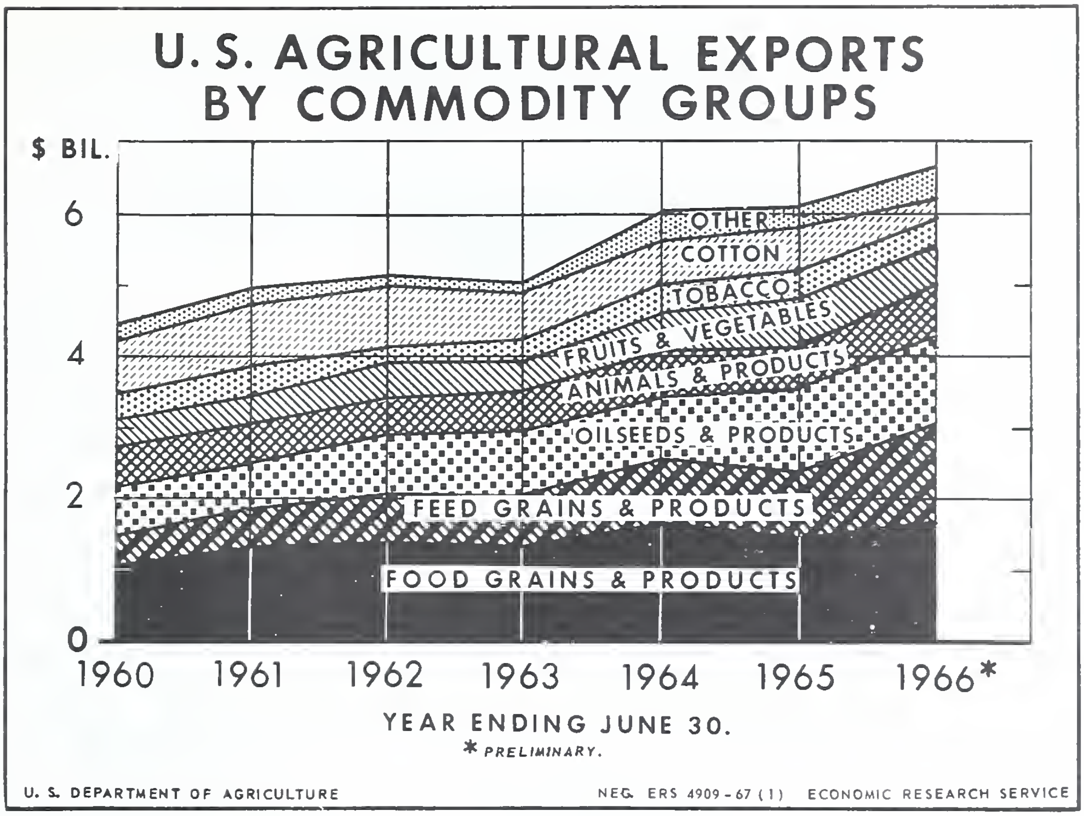
[10] Barlow, Frank D., Jr. and Susan A. Libbin. The Role of Agricultural Commodity Assistance in International Aid Programs. In Foreign Agriculture Economics, U.S. Dept., Agr., Econ. Res. Serv., ERS-Foreign 118, 26 pp., March 1965)

[11] Upchurch, M. L., U.S. Dept. Agr., Econ. Res. Serv., Speech entitled "Changes in United States Farm Production to Meet the Challenge of World Food Needs," presented before the Southwestern Conference on the World Population Explosion and Its Implications for Agriculture and the South, Baton Rouge, La., April 1966.

[12] The recent Canadian sales commitment over a 3-year period is the equivalent of 40 percent of that country's annual wheat exports during fiscal year 1964–66. This represents a sizeable portion of the Canadian exportable supplies over the next 2 years. However, the improved Russian crop in 1966–67 may result in a deferment of shipments in the current year.

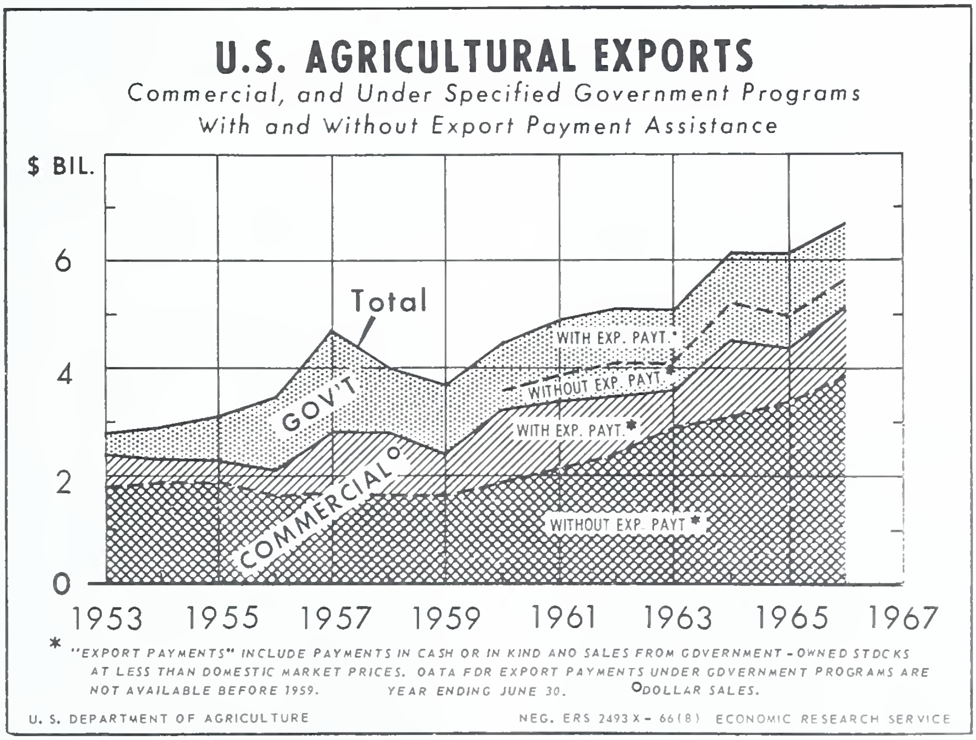

U. S. AGRICULTURAL EXPORTS BY COMMODITY GROUPS

YEAR ENDING JUNE 30.

* PRELIMINARY.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 4909-67 (1) ECONOMIC RESEARCH SERVICE

Figure 9

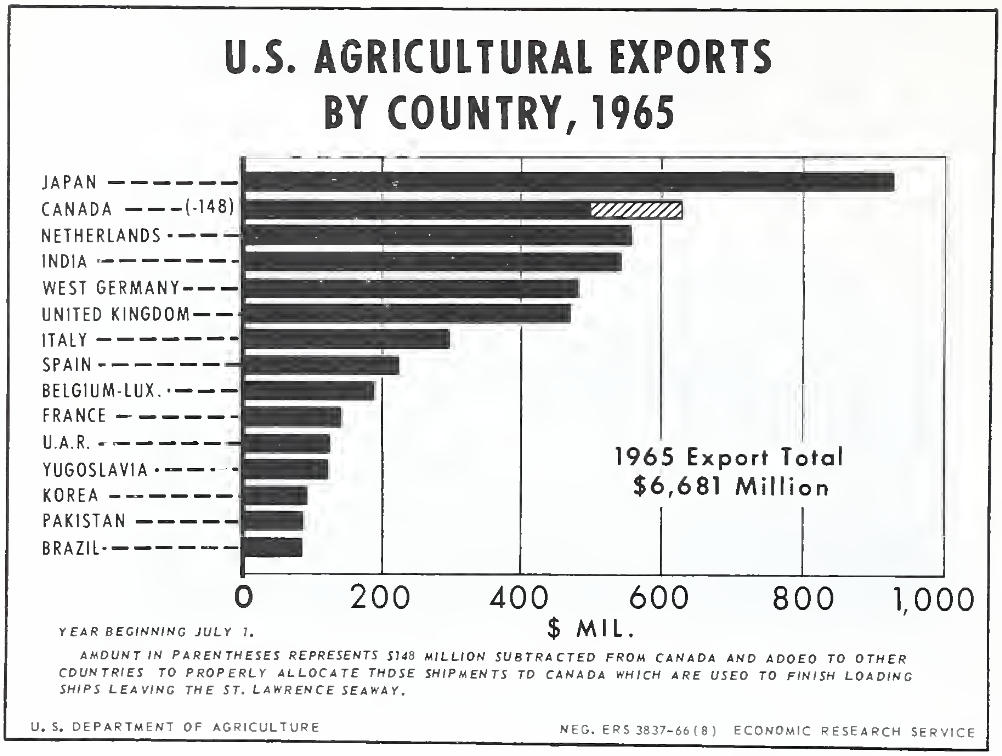

U.S. AGRICULTURAL EXPORTS

Commercial, and Under Specified Government Programs With and Without Export Payment Assistance

* "EXPORT PAYMENTS" INCLUDE PAYMENTS IN CASH OR IN KIND AND SALES FROM GOVERNMENT-OWNED STOCKS AT LESS THAN DOMESTIC MARKET PRICES. DATA FOR EXPORT PAYMENTS UNDER GOVERNMENT PROGRAMS ARE NOT AVAILABLE BEFORE 1959. YEAR ENDING JUNE 30. ° DOLLAR SALES.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 2493 X-66(8) ECONOMIC RESEARCH SERVICE

Figure 10


U.S. AGRICULTURAL EXPORTS BY COUNTRY, 1965

YEAR BEGINNING JULY 1.

AMOUNT IN PARENTHESES REPRESENTS $148 MILLION SUBTRACTED FROM CANADA AND ADDED TO OTHER COUNTRIES TO PROPERLY ALLOCATE THOSE SHIPMENTS TO CANADA WHICH ARE USED TO FINISH LOADING SHIPS LEAVING THE ST. LAWRENCE SEAWAY.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 3837-66(8) ECONOMIC RESEARCH SERVICE

Figure 11

raise the year-end carryover of feed grains to more adequate levels. Planting intentions indicate substantial increases for corn and grain sorghums but somewhat less than anticipated. But, in the case of soybeans, present indications are that soybean acreage will be up. Soybean price supports are being continued at $2.50 a bushel for the 1967 crop. If past trends continue, market prices may well average above this level. It will take an additional 2-1/2 million acres of soybeans to yield the 1-billion-bushel crop which is needed to meet the continuing upward trend in domestic and foreign market demand expected in 1967-68.

To a large extent, the strong foreign demands for feed grains and soybean meal are associated with each other, especially as the foreign feed mixing industry develops to meet feed requirements of rapidly expanding poultry and swine production in the industrial countries of Europe and Japan. Then, too, the production cutbacks in cotton reduce the availability of cottonseed for crushing and intensifying the need for greater increases in soybeans to meet the increasing demand for protein supplements.

A recent Economic Research Service study showed that the annual consumption of oilseed meals in the European Economic Community (EEC) averaged 5.1 million tons in 1962-63, a level more than double the 1954-56 average.[13] In 1970, the consumption is projected to range from 8.2 to 8.8 million metric tons as the EEC import policies for oilseeds are expected to remain favorable and internal prices will favor increased feeding of protein supplements.

Whether the future expansion in exports to the Common Market will be in the form of beans or meal is not entirely clear. There are some who believe, particularly in Europe, that EEC meal imports will continue to increase relative to bean imports because the future demand for oil in Europe is not expected to increase as much as for meal. They point to the increasing difficulty of EEC countries in finding export markets for oil. The majority opinion, however, is that the trend in the future may be toward oilseeds, particularly soybeans. They feel that crushers in the EEC will be successful in exporting oil in competition with the United States and consider two other factors that will affect the composition of exports--(1) the continuing expansion of the EEC oil-crushing industry, and (2) continued high level demand for meal in the United States.

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[13] Elz, Dieter. European Economic Community Import Demand for Oilseeds and Oilseed Products—A Summary. In Foreign Agriculture Economics. U.S. Dept. Agr., Economic Research Serv. ERS-Foreign 170. November 1966.

In view of strong foreign demand, rice allotments for 1966 were increased by 10 percent and recently extended to the 1967 crop. If commercial exports continue strong, as it now appears, the amount of rice available for concessional food aid programs will continue to be limited. And it should be observed that requirements for South Vietnam are expected to receive top priority into the foreseeable future. This certainly is a bullish factor in the outlook for the U. S. rice industry.

Concluding Remarks

In concluding, I would like to reemphasize several points. First, the great expansion in international trade in grains has occurred despite the disparities in grain prices between the exporting and importing countries and the trade restrictions imposed by importing countries. Fifteen years ago no one envisioned the near tripling of international trade in grains, the significant and sustained growth of oilseeds and oilseed product exports, or that the United States would share so well in this expansion. Neither did any anticipate the sustained growth that has occurred for cotton and tobacco.

As we view the short-term prospects, the commercial demand for wheat, feed grains, soybeans, and rice is about as strong as at any time we remember in the recent past. As surpluses disappear, the programming of concessional sales is being tightened up and every commitment is being scrutinized to ensure that food aid is channelled into high-priority uses. Yes, we are truly in the midst of a dynamic period in American agriculture.

SECOND SESSION: J. J. Mikell, Louisiana Agricultural Experiment
Station, Chairman

ADVANCES IN BREEDING NEW RICE VARIETIES

by

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Crowley

The United States rice industry is unique in many ways. Although rice is probably the leading food crop of the world and is grown on all continents, its production in the United States is confined to relatively small areas. Most of the rice is produced in Louisiana, Arkansas, Texas, California, and Mississippi. Less than 1 percent of the world's rice area of 230 million acres is grown in the United States; yet the United States produces almost 2 percent of the world's rice crop. It is anticipated that the United States may become the world's No. 1 rice exporter during the 1966-67 marketing year. During the previous year, Thailand led the world with rice exports of approximately 1. 9 million metric tons, followed closely by Burma and the United States.

Rice is the only cereal produced in the United States that has been gaining in per capita food use. This, plus the increase in the export market caused by inadequate world food supplies and the Food for Peace program, places an increasing demand upon the American rice farmer to produce more rice from the fixed acreage. Rice production per acre has shown a steady increase in the United States. This increase can be attributed to new technological advances--as new and improved varieties--increased use of fertilizer, control of rice insects and diseases, weed control, improved irrigation and drainage facilities, and better cultural methods.

The development of improved varieties has played a major role in increasing yields per acre. The average yield per acre increased from 1,091 pounds per acre in 1895 to 4,300 pounds per acre in 1966. Except for the war years of 1941 to 1945, rice yields have continually shown a gradual increase. In fact, the average rice yields have doubled in the last 20 years and the prospect for continued yield increases is very encouraging. It is not uncommon to find yield data in the southern rice area reporting yields in excess of 6,000 pounds per acre. Research has demonstrated that the present rice varieties are capable of producing considerably higher yields than the average yields now obtained by rice producers.

Although rice has been grown in the United States since the latter part of the 17th century, comprehensive, cooperative rice-breeding studies did not begin until 1909 in Louisiana, 1912 in California, 1931 in Texas and Arkansas, and 1958 in Mississippi. Rice breeding at these locations is conducted cooperatively by the U. S. Department of Agriculture and the respective State Agricultural Experiment Stations. Hybridization as a breeding method did not begin until 1922. Before that time, the commercial varieties came directly from introductions or selections from natural hybrids between varieties.

The earliest variety grown in Louisiana was "Carolina," a chance introdution from Madagascar first grown along the eastern coast of the United States. Later, "Honduras," another long-grain variety of similar maturity, was introduced into southwest Louisiana. Short-grain Japanese varieties were introduced in the 1890's. S. L. Wright, a farmer from Crowley, La., developed varieties by selection. He was very successful and produced several varieties which proved to be the leading varieties in the southern rice area from 1915 to 1945. These varieties included Blue Rose, Early Prolific, Edith, and Lady Wright.

The cooperative rice breeding program of the U. S. Department of Agriculture and the State Experiment Stations of Louisiana, Texas, and Arkansas, was given new emphasis in the early 1930's with the assignment of three U. S. D. A. rice breeders to the Rice Stations of these States. A hybridization program was initiated in order to develop suitable, high-yielding varieties, adapted to the southern rice growing area. The primary objective of the breeding program was to produce varieties that would assure good production of the types required by the producers and consumers. A U. S. D. A. rice breeder was also assigned to the Rice Station in California. Today, these four rice stations conduct almost all of the rice breeding investigations. At present, three commercial seed rice firms--two in Louisiana and one in California--carry on some varietal improvement work. However, only the California company has released a variety and it has had limited acceptance.

The breeding methods that are commonly used for small grains are also used in rice breeding. They include (1) introductions, (2) selections of pure lines from commercial and introduced varieties, and (3) hybridization and selection. In earlier years, introductions accounted for 9 or 10 commercial varieties, none of which are grown now. All introductions are now used primarily as a source of breeding material and all are grown in isolation away from the rice growing areas for the first year.

Practically all of the United States varieties grown from 1920 to 1945 were developed through selections. Some of the more notable varieties developed in this manner include Blue Rose, Caloro, Colusa, Early Prolific, Fortuna, Nira, and Rexoro. Others developed by pure-line selection include Bluebonnet 50, Sunbonnet, and Zenith. These varieties played an important role in the American rice industry. Rexoro was a very high quality rice and has been used in the development of present day long-grain varieties.

In the 1930's, almost 75 percent of the U. S. medium grain crop was Blue Rose. This variety has been used extensively in the breeding program for improved medium-grain varieties. Zenith proved to be a widely accepted medium-grain rice until the development of superior varieties through hybridization. With a few exceptions, varieties developed by the selection method have been replaced by newer varieties. In 1963, Bluebonnet 50 was the leading variety in the South. Its popularity has begun to decline, but in 1966 one-fourth of the Southern production was from Bluebonnet 50. Caloro and Colusa still account for approximately one-half of the California acreage.

As indicated earlier, the rice breeders in the United States have used the hybridization method of rice breeding to incorporate the desirable characteristics of two or more varieties into a single variety. Although the bulk method and backcrossing system have been used, the pedigree method is the most widely adapted method currently used to develop new varieties. Modifications of the pedigree and bulk systems are frequently followed also.

The breeding objective are many and varied. The ultimate aim is to develop superior, high-yielding varieties that are acceptable to the trade and are adapted for production in the rice growing area. The objectives sometime vary to meet specific needs of an area and changes in processing techniques. For example, the necessity for varieties adapted for mechanical harvesting resulted when the rice combines were developed. Commercial drying also imposed additional restrictions that had to be incorporated into rice varieties.

Water seeding of rice in Louisiana made it necessary to develop varieties that were adapted for that purpose. The increased use of applied nitrogen fertilizer increased the demand for varieties resistant to lodging and disease. The plant breeder continually has had to be aware of the approaching problems and to be prepared to develop varieties accordingly. The breeding objectives include:

1. High field yields.
2. Resistance to disease and insects.
3. Good cooking and processing qualities.
4. Response to high levels of fertilizer.
5. Seedling vigor and cold tolerance for early seeding.
6. Tolerance to alkalinity and concentrations of salt.
7. Shorter and stronger straw-strength.
8. High milling yields.
9. Uniform maturity.
10. Acceptable grain types.

In additiion to the generally recognized objectives for rice varieties, there are some special purpose needs that are considered in the current breeding program. These include the development of varieties with high protein content; varieties adapted for special industry needs such as cereals and beer; and the development of varieties to meet specific needs of certain areas.

There are about 14 varieties of commercial importance in the United States. However, six of these varieties accounted for about 86 percent of the 1966 U. S. rice production. They were Bluebonnet 50, Belle Patna, Bluebelle, Nato, Saturn, and Calrose. The 1967 rice season will apparently bring about some changes in the varietal situation because of the recent release of improved long-grain varieties.

Rice varieties are classified into three main groups according to grain length and width. These are long-, medium-, and short-grain varieties. The variety composition has changed considerably in the last 30 years. For example, in 1936, 15 percent of the crop was long-grain rice; 65 percent was in medium-grain varieties; and 20 percent was devoted to short-grain rice. In 1966, the rice crop consisted of 43 percent long-grain, 46 percent medium-grain, and 11 percent short-grain. The Southern States did not grow short-grain varieties, and no long-grain varieties were grown in California. The variety picture varies from State to State. For example, in 1966, Louisiana rice growers produced 77 percent from medium-grain varieties and only 23 percent from long-grain varieties. In Texas, the situation was almost completely reversed, with long-grain varieties accounting for 79 percent of the Texas production and medium-grain varieties accounting for the remaining 21 percent. Rice production in California was almost equally divided between short- and medium-grain varieties.

The leading long-grain varieties are Bluebonnet 50, Belle Patna, and Bluebelle. Belle Patna has led to the development of increased yields in Texas by its early maturity and ability to produce a stubble crop. Dawn, a new variety released in 1966 by the U. S. Department of Agriculture, Crops Research Division in cooperation with the Texas, Louisiana, Arkansas, and Mississippi Agricultural Experiment Stations, may alter the varietal picture in 1967 and subsequent years. Another long-grain variety, Starbonnet, released in 1967 by the Arkansas Agricultural Experiment Station, may eventually replace Bluebonnet 50. Dawn and Starbonnet possess desirable agronomic characteristics. The Dawn variety is resistant to the prevailing races of the blast disease, produces high field yields, and is moderately resistant to lodging. Starbonnet matures about 1 week earlier than Bluebonnet 50, grows about 15 percent shorter, and has averaged higher field yields. It has cooking and milling qualities similar to Bluebonnet 50 and should be readily accepted by the market. Unfortunately, it is not resistant to the blast disease and therefore, may be excluded from production in southwest Louisiana.

Medium-grain varieties accounted for 46 percent of the 1966 U. S. production. The main varieties are Nato and Saturn for the South and Calrose for California production. Both Nato and Saturn were released by the Louisiana Agricultural Experiment Station through the cooperative U. S. D. A. -State program. Nato possesses good field yields and exceptionally high milling yields. It is susceptible to a prevalent race of Piricularia (blast) and late-seeded fields are often injured by leaf and neck blast. Saturn was released by the Louisiana Rice Experiment Station in 1964 as a variety resistant to the prevalent races of the blast disease. It is a very productive variety and has been partly responsible for the recent increases in Louisiana rice yields. Several area farmers have reported green weight yields of over 7, 000 pounds per acre and one farmer produced 8, 000 pounds per acre from this variety. Because of the high field yields, it is likely to lodge if exposed to heavy rains and winds after the grain begins to develop. A new variety from Arkansas, Nova 66, may prove to be a suitable variety in areas where blast is not a problem.

The development of short-grain varieties is primarily confined to the California rice area. However, industry people have requested a short-grain variety for the South to be used for extruded processes in the cereal industry and also to meet limited demands for exports. This development is recent, and consequently the time has not been sufficient to produce these varieties.

The new, improved rice varieties have made their impact upon the economy of the rice growing regions of the United States. These advances have been made possible by the cooperation of Federal and State research workers, extension personnel, industry, and the rice farmers. The significant advances include many of the breeding objectives previously mentioned. However, the release of high yielding, blast-resistant varieties, such as Saturn and Dawn, or the development of short-season varieties, such as Belle Patna, which enables the production of two crops per year through stubble-cropping, is of particular significance. The potential for even greater contributions to increased rice production through varietal development makes the rice situation in the United States appear very promising.

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INCREASING SOYBEAN PRODUCTION

by

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Most of you realize that soybean production has been expanding in the Southern States. However, it might be well to review briefly the extent of this increase and also how it relates to total U. S. population. The value of soybeans produced in the 13 Southern States in 1966 was over $690 million. We produced 26. 5 percent of the U. S. soybean crop but planted 29 percent of the acreage. Our average yield of 23. 3 bushels per acre was 2 bushels below the U. S. average. Five years earlier we planted 24 percent of the acreage and produced 20 percent of the crop. Ten years ago we produced 15 percent of the U. S. crop on 19 percent of the acreage. Our average yield of 23. 3 bushels in 1966 was 2 bushels below the U. S. average yield, but in comparison with our 1961 average of 21. 2 bushels or of our 1956 average of 17. 7 bushels, the average yields of 23. 3 bushels represents progress. In 10 years our total production has increased from 70, 535, 000 bushels to 246, 532, 000 bushels. Information developed through research and distributed by workers in extension service has been an important factor in making this increased production possible. Average yields in each of the Southern States could now be at least 30 bushels per acre, if more growers were utilizing available information relative to production practices.

Research leading to the development of improved varieties, improved fertilization practices, improved weed control, improved insect control, and improved harvesting equipment have been major factors contributing to more efficient production. Along with this we have a crop well suited for mechanized production and also a crop which as a producer of protein and oil fills a real need in today's world economy.

Nearly all southern soils, other than the alluvial soils along the Mississippi River, are low in phosphorus or potash. Soybeans will respond to application of these materials when they are limiting. A soil test is an excellent guide to determine needs. Generally when the soil test shows phosphorus or potash availability to be low, a response can be expected from these materials. Where the soil test shows availability to be medium, a response may or may not be obtained. However, to permit the soybean to respond to these materials, the soil pH levels of 5.8 to 6.5, nodule bacteria can operate efficiently and will supply an adequate quantity of nitrogen for the soybean plant.

As soybean acreage expanded, much of the acreage was planted on land heavily infested with weeds and little attention was given to controlling these weeds. Consequently, weeds have been a major limiting factor in soybean production. At Stoneville, yield reductions of 50 percent have been obtained from competition with moderate stands of Johnson grass. Other weeds give similar competitive effects. Increased usage of preplanting, preemergence, and post-emergence chemicals plus greater attention to cultural practices is resulting in more weed-free soybean fields. As the number of weeds reaching maturity is reduced, the weed problem in soybean fields gradually will be lessened.

Seed holding or shatter resistance was of little concern to the Asiatic soybean grower who grew plots harvested by hand by his family. However, for our mechanized production, shatter resistance is a major varietal attribute. Ogden was the major variety produced in the South in 1955. Ogden has better seed holding qualities than most types from Asia but losses from shattering were common. The variety Lee released in several of the Southern States in 1954 is highly resistant to shattering. Little or no shattering is expected 6 weeks after it is mature. The varieties Hill, Bragg, Semmes, Pickett, and Hampton have this same degree of shatter resistance.

In the Lee variety we also introduced resistance to the foliar disease bacterial pustule. This disease could be found in nearly all soybean fields in the South when susceptible varieties were grown. Yield reductions of 8 to 15 percent were common. At present all major varieties grown in the South are resistant to this disease.

Another foliar disease, target spot, can reduce yields of susceptible types by as much as 50 percent. All major varieties are highly resistant to this disease.

Much of the soybean production on the alluvial soils of the Mississippi Valley is on clay. This soil is favorable for the development of the disease phytophthora rot. Injury from this disease throughout the season can range from failure to emerge to killing. It may only be root injury making the soybean plant a poorer host for nodule bacteria. The varieties Lee, Bragg, and Hill are rated as moderately resistant. More recent releases such as Davis for northeast Arkansas and Semmes for Mississippi, Arkansas, and Louisiana have a higher degree of resistance and will aid in raising the level of productivity for the more poorly drained clay areas.

Root-knot nematodes are present in many of the lighter textured soils of the Southeast. Differences among varieties in reaction to the common cotton root-knot nematode are apparent. The varieties Hill and Bragg have good resistance. This resistance is adequate to greatly reduce the nematode population in the soil.

Cyst nematodes have received considerable attention in recent years. Injury can be severe. The resistant variety Pickett was released in North Carolina, Virginia, Tennessee, Missouri, and Arkansas in 1965. An earlier maturing variety, Dyer, is being released in Tennessee and Missouri. Dyer is also resistant to root-knot nematodes. With these varieties there is no reproduction of the cyst nematode.

In our breeding program we have given considerable attention to reducing the hazards of production through resistance to shattering, lodging, diseases, and nematodes. We believe that this has been a major factor in increasing and stabilizing seed yields. We frequently hear that as soybean acreage expands we must expect more disease problems. However, by giving recognition to potential problems in the breeding program, many problems can be avoided.

Nearly all soybean varieties presently in production will average 40.5 percent protein and 21.0 percent oil on a dry-matter basis. This means that a tone of soybean contains approximately 715 pounds of protein and 370 pounds of oil. Based upon 10-year average prices for protein and oil, the protein of soybeans has been worth 58 percent of the total value of the seed. Without PL-480 to remove excess oil, the percentage value of the protein probably would have been greater.

Considerable variability exists among soybean genotypes for protein and oil content of the seed. Oil and protein content in the seed are negatively correlated. Thus, as we increase protein content by 10 percent, we must expect a nearly similar percentage reduction in oil. Progress is being made in developing higher protein types with good productivity. Most parental material having genes for high protein have been low yielding and susceptible to several diseases. We have developed types that will produce a higher percentage of protein and that have equalled standard varieties in productivity at Stoneville (table 1).

Other types with good agronomic qualities are also being developed (table 2).

Results obtained are encouraging in that if a market develops for soybeans with higher protein, productive varieties can be made available.

During the period 1956 to 1966 soybean acreage in the 13 Southern States increased from 3,976,000 acres to 10,603,000 acres. Along with this acreage increase, seed yield per acre increased 32 percent. Considerable additional acreage that could grow soybeans profitably is available. A considerable acreage is now out of production through operation of the cotton program. Possibly soybeans could be grown profitably on as much as 6 to 8 million acres in the Gulf Coast area of Louisiana and Texas. Another several million potential acres are in the flatwood areas of the Carolinas, Georgia, and Florida.

Additional research is needed to utilize these potential areas most efficiently. However, it appears that the soybean crop has a bright future in the South.

Table 1.--Comparison between two standard varieties and two high protein strains, Stoneville, Miss., 1961-1965.

Strain	Seed per acre	Protein	oil	Ratio of protein to oil
	Pounds	Percent	Percent	
Lee	2,328	40.7	21.9	1.86:1.00
D60-9647	2,376	45.1	19.4	2.32:1.00
Jackson	2,274	39.4	21.9	1.80:1.00
D60-8107	2,286	45.0	18.6	2.42:1.00

Table 2.--Comparison of D49-2491 with third backcross lines using the wild type, PI 163.453, as the nonrecurrent parent

Strain	Seed yield		Protein	Oil	Percent of total value in protein
	Lb./acre	Percent	Percent	Percent	
D49-2491	2,226	100	41.7	20.9	58
D64-4830	2,166	97	45.9	17.1	65
D64-4833	2,232	100	43.2	19.5	60
D64-4841	2,118	95	47.4	17.4	65

STATUS OF THE DEVELOPMENT OF GLANDLESS COTTONSEED

by
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The purpose of this paper is to review briefly the nature and significance of pigment glands in cottonseed, development of breeding stocks of gland-free seed, limited experience in processing glandless seed, and the general status of progress toward commercial production of glandless cotton.

The need for glandless seed is created by the undesirable effects which gossypol and gossypol-like pigments exert upon the unrestricted usefulness of cottonseed protein and cottonseed oil--the two primary products from the processing of cottonseed. Boatner (2) reviewed these pigments and their storage in so-called "glands" in the cottonseed. These pigment glands are dispersed throughout the kernel and may be observed as dark specks in a cross section.

The gland wall is composed of six to eight cell plates surrounded by a gelatinous-like covering. The wall remains intact upon exposure to most solvents, such as the commercial hexane, that is used in oilseed processing. The wall, however, is highly susceptible to rupture by water, especially at elevated temperatures.

While the pigments contained in the glands are not soluble in water, the penetration of the gland wall by water causes them to be expelled in a rapidly moving stream of finely divided particles.

Gossypol, a principal constituent of the content of cottonseed pigment glands, is a highly reactive polyphenolic compound which derived its name from Gossypium phenol. It has been well documented in the literature that it causes cottonseed oil to be difficult to bleach to a satisfactory color, contributes to olive yolk discoloration of stored eggs, reduces the availability of certain essential amino acids when gound to cottonseed protein, and even causes toxicity if fed in too large amounts to young swine or poultry. More recent investigations have established that it may hinder the use of cottonseed protein in certain human foods and industrial applications because of the color it imparts.

Pons and coworkers (19) demonstrated that the gossypol content of cottonseed is influenced by both climatic environment and heredity. The Hopi cotton of central Arizona was shown by Lewton (12) and Fulton (4) to have variable numbers of pigment glands.

McMichael (13) reported that selections from the variety Hopi Moencopi had boll and leaf gland content reduced almost to zero. He used the character as a genetic market to study natural crossing. By crossing Hopi M to upland varieties, he was able to produce glandless seed (14). Later (15) he reported the glandless seed character to be the expression of two recessive genes--gl_2 and gl_3.

It was shown that the earlier glandless leaf character was inherited from the recessive genes that contribute to glandlessness. Roux (20) hypothesized that the glandless genes 2 and 3 were partly dominant, but the studies of Lee (10) and Miravalle (17) support McMichael's recessive hypothesis and Roux's conclusions may have been influenced by the presence of dominant genes $Gl_{4, 5,}$ or 6. It is generally agreed that a plant homozygous for gl_2 and gl_3 produces seed free of pigment glands. It may be of practical importance to breeders that Fuchs (3) has observed that a heterozygous GL_3gl_3 may fail to show seed glands unless one of the modifier dominant genes is present.

Many breeders had begun a program to incorporate glandlessness into their varieties before McMichael published in 1960 on how the character was inherited, but progress was slow. Work by Miravalle and Hyer (18) showed how the double heterozygote for the two and three genes could be recovered with a saving of a segragating generation for each backcross. A conference held by the United States Department of Agriculture, Mississippi Agricultural Experiment Station, and National Cottonseed Products Association (22) appeared to create a better understanding of the most suitable breeding procedures.

The Egyptians claim to have produced a glandless variety of Gossypium barbadense, in contrast to our *Gossypium hirsutum* by inducing a mutation with P^{32}. According to the information available, their glandlessness is controlled by one dominant gene, whereas, glandless cotton being used in this country is the result of two homozygous recessive genes. Unfortunately, seed of their cotton is unavailable, at least at the present, to breeders here.

Everyone has agreed that glandless cotton cannot be successfully grown commercially until strains or varieties are available which will provide the grower with as much, or more, income than that of competing glanded varieties. Because seed is more nearly a byproduct than a coproduct of cotton lint production, this has meant, in realistic terms, that glandless cotton must be equal to glanded cotton in other respects such as fiber yield and quality, freedom from disease susceptibility, suitability to harvesting procedures, no more costly to control insects, and the many other factors that affect the net income from cotton production. If we had been dealing only with seed, such as is the case with soybeans, glandless cotton would undoubtedly already be in extensive commercial production.

In addition to the need to keep fiber yield and quality requirements as an essential goal, several other obstacles have appeared to restrict breeding progress to some degree. First, the extreme urgency to improve cotton's competitive position has made it necessary to give fiber quality and yields preference over glandlessness in the program of nearly all cotton breeders. Second, most breeders have always been "a step behind" with their glandless lines because they have been attempting to incorporate the character into existing varieties at the same time they are conducting separate programs to improve the yields and fiber quality of those glanded varieties. Third, because some insects appear to prefer glandless cotton, some breeders have appeared to have held down the intensity of their breeding programs temporarily while they await the outcome of insect preference studies. Finally, most breeders have been convinced that their individual release of a glandless line would be of questionable economic advantage to them, because it is realized that glandless seed will have to be produced in large separated volumes to enable the mill to keep it uncontaminated with glanded seed and thereby create a margin between the price of glandless and glanded seed.

Despite these obstacles, we must conclude that remarkable progress has been made.

A glandless variety of cotton was released for the first time in 1966 and was grown on about 15,000 acres on the South Plains of Texas. Its parent variety was a short staple cotton. The new variety involved the introduction of outside genetic materials and it was released as a Verticillium wilt-resistant cotton without reference to its glandlessness. Because of the extremely poor season in 1966 in South Plains of Texas, evaluating the variety was difficult. Some growers did not follow the breeder's recommendations on planting rates and amount of irrigation. During the normal heavy fruiting period, the area had excessive rainfall and an exceptionally early freeze destroyed a large part of most varieties. However, when we confine our evaluation to a comparison of the glandless variety with its older parent glanded variety, we get the impression that glandlessness was in no way a handicap to performance. I hasten to add that not everyone agrees with our evaluation. However, the new cotton appeared to have equal or better staple length, micronaire was improved, and it had greater tolerance for Verticillium wilt. Some reported that it was more susceptible to bacterial blight and was somewhat lacking in stormproofness.

The breeder of the cotton claims his Gregg 25V glandless variety outyielded his glanded Gregg 35 and 45 on wilt-infested and nonwilt land for 3 years. Gregg 25V has slightly longer staple than his glanded varieties. He says the Pressley average is about 90,000 pounds, which is about typical of the old Gregg 35, and that the Gregg 25V has a micronaire 3 to 5 points higher. He claims it has a very vigorous seed and recommends a lower rate of planted seed per acre and says that it requires less irrigation, which permits it to be harvested about 10 days earlier than Gregg 35. Unfortunately, there are no official tests comparing this glandless variety with glanded varieties. In some demonstration variety trials conducted in Hockley County, the Gregg 25V glandless was first in performance in two demonstrations and second in a third. However, in neither of these trials were all varieties included. Incidentally, before releasing the variety, the grower carried it for 15 generations in his breeding program. We have learned from cotton oil mills that the Gregg 25V had a slightly higher seed grade than the usual run of seed received from the 1966 crop.

It appeared earlier in the year that the acreage for 1967 would be increased. Now, it appears that growers in that area have become so acutely aware of the need to improve their fiber quality that they will be planting a very significant part of their 1967 acreage to varieties that are known for fiber quality and that have never before been grown extensively in the area. This trend is expected to have a marked effect upon the variety situation at least for 1967. Therefore, less of the first commercial glanded cotton probably will be grown in 1967 than was grown in 1966.

Let us turn now from this first commercially grown glandless variety to others that have not yet been released. Over the broad view, it appears that the smaller breeder is closer to the decision to release glandless cotton than is the larger breeder. One breeder reports that he will have two lines of glandless cotton increasing on 1, 000 to 1, 500 acres in Texas in 1967. The breeder who released the first glandless variety will be increasing on 650 acres. Six other breeders have reported to us that they will be increasing glandless cotton for commercial release. Some of these acreages are rather small; in these cases the increase program, in my opinion, is also a part of a testing program and the breeder could discard the variety or line without great loss of effort.

It is encouraging that 19 breeders are still using the Iguala, Mexico, Winter Breeding Station to obtain two generations a year.

As early as the 1960 crop year the Association and research organizations with whom it was cooperating began to obtain small lots of glandless seed for laboratory processing to determine the quality of the products that might be produced. These small lots were seed that had been discarded or that were in surplus in the breeding program at the U. S. Cotton Research Station, Shafter, Calif. The lots represented a conglomerate of lines with Acala 4-42 background. The Cottonseed Products Research Laboratory processed the seed for hexane extraction, according to the procedure described by Lawhon and Wamble (9). The Southern Utilization Research and Development Division processed the seed for hexane-acetone-water extraction, according to the procedure described by Mann and coworkers (16). Results were highly favorable to the glandless seed.

The extremely high quality of the cottonseed oil was reported by Thaung and coworkers (21), Williams (23), Aines[1] and Simmons[2].

The improved usefulness of the protein concentrate is demonstrated in the reports of Johnston and Watts (8), Heywang and Vavich (5, 6), Lyman and Hale[3], Anderson and Warnick (1), and Hill and Totsuka (7).

Through the assistance of the U. S. Cotton Research Station, Shafter, Calif., and the Camp Ranches we secured about 40 tons of glandless seed for processing in a commercial mill in 1966. The seed had a small amount of mixture with glanded seed and the volume was so low that less than optimum conditions could be used in the commercial mill. One ton of the seed was shipped to the Cottonseed Products Research Laboratory to be processed in the same manner that earlier lots of glandless seed had been processed to evaluate comparative results.

Figure 1 graphically shows the EAF lysine nitrogen solubility values for commercially processed glanded meal, commercially processed glandless meal, and laboratory or pilot plant glandless meal. The most striking improvement came from substituting glandless for glanded seed in the commercial mill, but further improvements were made in laboratory processing and this is what we expected.

Because the commercial mill had not been completely cleaned of glanded cottonseed materials, there was some gossypol contamination. Figure 2 shows how this contamination affects oil color.

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[1] Aines, P. D. Personal communication. 1963.

[2] Simmons, R. O. Glandless Cottonseed Symposium. Amer. Oil Chemists' Soc. Meeting [Unpub. Rpt.] . April 1965.

[3] Lyman, C. M., and Hale, F. Personal communication to National Cottonseed Products Association's Research and Education Committee. 1964.

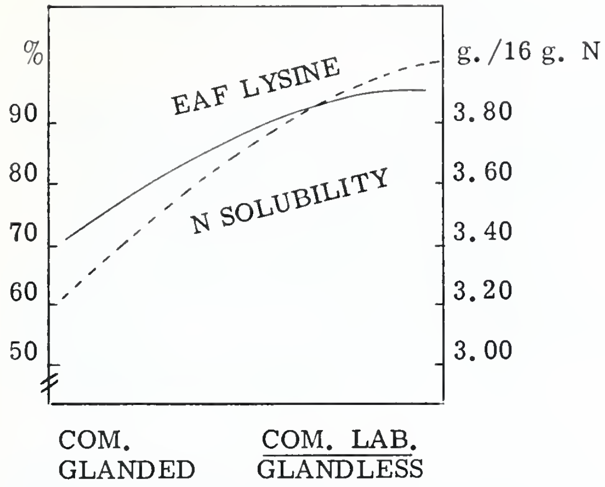

Figure 1.--Nitrogen solubility and available lysine of glanded and glandless cottonseed meals.

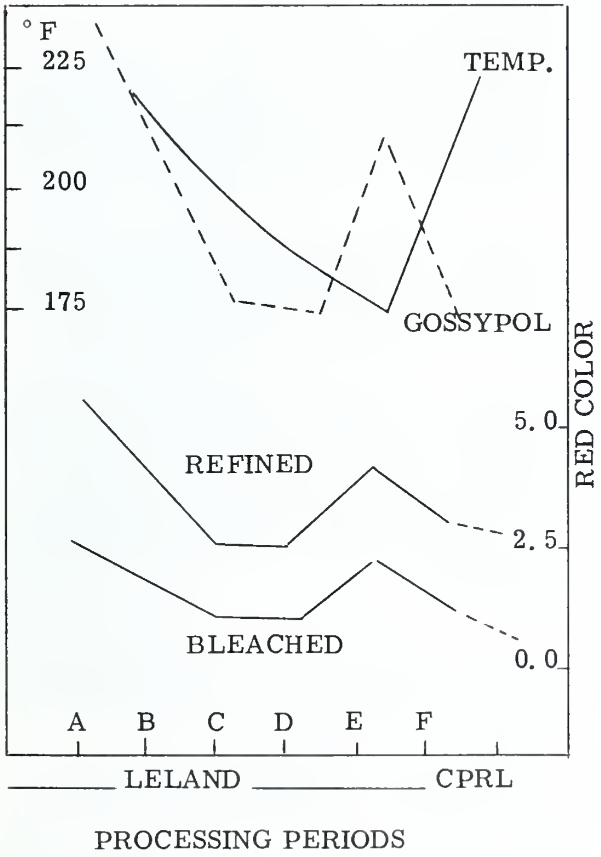

Figure 2.--Relationship of cooking heat to color of glandless oils.

Visual inspection of various samples of glanded and glandless oils illustrates the effects of gossypol on color. In earlier experiments the Southern Regional Research Laboratory processed glandless seed with and without the addition of gossypol during processing and the oil to which gossypol had been added showed color quite similar to that of glanded oil.

A much more extensive test of commercial processing of glandless seed will be made at the Plains Cooperative Oil Mill during the week of April 9, 1967, when about 700 tons of the glandless seed will be processed under special conditions.

In conclusion, we should take a good look at how greatly glandless seed is needed to maintain or improve the competitive position of cottonseed and its products. Even with all of the work that has been done to permit more extensive use of glanded cottonseed meal in rations fed monogastric animals, the industry still depends upon the cattle and sheep market for 70 to 75 percent of its market.

This market for dietary nitrogen for ruminant animals is being rapidly taken by urea and other nonprotein nitrogen sources.

In addition to gains that can be made in the monogastric animal feed market by using glandless cottonseed meal, we have an opportunity to get cottonseed protein into human foods and industrial uses if we can solve the gossypol problem.

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ADVANCES IN COTTON BREEDING

by
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It is a pleasure to speak briefly on advances in cotton breeding, because significant advances are being made. The need for further advances is urgent, and the opportunities for them are good.

Cotton breeding in the United States is conducted by State and Federal agencies and by private seed companies. The liaison and understanding among cotton breeders and geneticists result in a comprehensive and coordinated total program. This program includes very basic research on the taxonomy, cytology, cytogenetics, and genetics of the genera of plants to which cultivated cottons belong. It includes basic studies on the nature of resistance of cotton to nematodes, diseases, and insects. The total program includes work which I like to refer to as developmental breeding. In this work, new ideas are tried out. It is not possible to know in advance what problems will arise or how long it will take to accomplish a new or complicated objective. Finally, the program includes applied breeding where the efforts result in the release of new varieties. The concept of basic, developmental, and applied research is somewhat arbitrary, because the stages overlap and phase into each other. We think a balanced program of these stages of work, considering the cotton breeding fraternity as a whole, is essential. A balanced program responds to problems that arise on the farm and in the mills. It is alert to new possibilities discovered by basic investigations.

Time will not allow a discussion of all cotton breeding and genetic activities. I want to confine my remarks to advances toward four objectives: (1) breeding for high fiber quality, (2) disease resistance, (3) adaptability for machine harvest, and (4) glandless (gossypol-free) seeds.

Fiber Quality

Breeders are placing great emphasis on fiber properties--staple length, tensile strength, micronaire, and uniformity. These are measurable properties of raw cotton which largely determine spinning performance in textile mills. Breeders are able to breed into varieties the inherent capacity to produce fiber properties to predictable specifications subject to variations around the varietal mean imposed by cultural and ginning practices. The effort for improved fiber quality is a natural response by breeders to several factors: (1) Competition by man-made fibers and foreign cotton production is keen; (2) modern spinning machinery requires high quality cotton in order to run properly at high speeds and to operate relatively trouble-free with automated controls; (3) certainly breeders in the Southeast, Midsouth, and High Plains have been stimulated by the unprecedented prices being paid for Western-grown Acala cotton, which sold this past season for 6 to 12 cents per pound over loan values. These Acalas contributed virtually no cotton to the surplus; and (4) a large surplus of other cottons has resulted in rather drastic acreage reductions.

Average values of prominent commercial varieties grown in the West illustrate the inherent differences among these varieties. The data in table 1 were adapted from U. S. Dept. Agr. ARS 34-82, publication entitled "Results of 1965 Regional Cotton Variety Tests--(Western Regional Summary).

Notice that the essential difference between Deltapine and the Acalas is the increased fiber strength, uniformity, and yarn strength. Acala 1517V excels the other three in staple length.

This year two new varieties have been released for production in the West. One is Acala SJ-1 which will replace Acala 4-42 as the approved variety in the one-variety district in the San Joaquin Valley of California.

The determining factors in the decision to release Acala SJ-1 were an 8 percent increase in yield, 1/32 inch longer staple, better midseason retention of fruit, 7 to 10 day earlier maturity, and spinning performance equal to that of Acala 4-42.

Table 1. --Average values of prominent commercial varieties, 1965.

Variety	Span length 2.5 pct.	Length uniformity 50/2.5[1]	Fineness micronaire	Yarn strength T1	Yarn strength of 22's
	In.	Ratio		G./tex	
Acala 4-42	1.11	47	3.8	20.7	140
Acala 1517V	1.21	46	3.8	21.4	150
Hopicala	1.14	47	3.8	22.1	149
Deltapine Smoothleaf	1.11	44	3.9	18.3	124

[1] 50-percent span length divided by 2.5-percent span length.

Acala SJ-1 has a lower lint percentage and a slightly higher micronaire. It remains to be seen whether this decision will be popular with producers and the processors after they have tried the new variety a season or two; however, data and experience to date indicate that Acala SJ-1 is superior to Acala 4-42.

The other variety is Acala Imperial released for growth in the hot valleys of southern California. Acala Imperial has fiber and spinning properties approaching those of Acala 4-42. It remains to be seen whether it will be favored by growers over popular Delta-bred varieties.

This brief look at the fiber and spinning properties of cottons now being favored by mills serves as an introduction to advances in breeding for higher quality cotton in the Southeast and Midsouth.

The breeding of high-quality cotton has been an objective in the Southeast and the Midsouth at least since the interspecies hybrid work began 25 years ago. It has been difficult to combine the factors for proper length, strength, micronaire, and uniformity with the boll size, lint percentage, earliness, and prolificness required for high yields. High quality cottons have been around for years in this area--they just would not yield enough for economical production. The Acala cottons produce good quality when grown in the East, but they do not yield enough over here to warrant their production. In 1964, breeders in the Southeast and Midsouth, both public and private, organized a regional high quality test. The tests were patterned after the regional cotton variety testing program and became an official part of that program.

The data in table 2 are adapted from the five Southeastern Stations in the 1965 regional high-quality tests.

The Coker Pedigreed Seed Company has released Coker 413. In 1966, approximately 15,000 acres were grown. I am told it was favorably received by producers and by mills that purchased the cotton. Approximately 300,000 acres will be grown in 1967. TH 149 has been released as a noncommercial breeding stock by the North Carolina Agricultural Experiment Station and the USDA. PD 165 and PD 259 have been released as noncommercial breeding stock by the USDA and the South Carolina Agricultural Experiment Station. The noncommercial stocks are now available to breeders for whatever purpose they find them useful, either for crossing, selecting, or increasing as they are. A selection of Atlas was increased by the Georgia Agricultural Experiment Station for production in 1967.

The data in table 3 were adapted from the six Delta Stations (including College Station, Tex.) in the 1965 high-quality test.

The central facts to be appreciated from the results of the regional high quality tests are: (1) Eastern bred cottons with improved length, strength, and spinning performance equalling or approaching that of western Acalas are now becoming competitive in yield with established commercial varieties; (2) the improved cottons are just beginning to be increased and released to growers; and (3) if these cottons are popular with growers

Table 2. --High-quality cotton varietal tests from five Southeastern stations, 1965

Variety	Yield of lint	Span length 2.5 pct.	Length uniformity 50/2.5[1]	Fineness micronaire	Fiber strength T_1	Yarn strength of 22's
	Lb./acre	In.	Ratio		G./tex	
TH 149	927	1.17	49	4.3	20.2	142
Carolina Queen	934	1.13	48	4.5	17.8	124
Atlas (A&C)	879	1.09	49	4.5	21.2	140
PD 165	855	1.20	48	4.5	22.0	149
PD 259	851	1.15	48	4.4	20.5	141
Coker 413	851	1.17	47	4.1	19.0	138
Hopicala	710	1.09	50	4.0	21.2	143

[1] 50-percent span length divided by 2.5-percent span length.

Table 3. --High-quality cotton varietal tests from six Delta Stations (including College Station, Tex.), 1965.

Variety	Yield of lint	Span length 2.5 pct.	Length uniformity 50/2.5[1]	Fineness micronaire	Fiber strength T_1	Yarn strength of 22's
	Lb./acre	In.	Ratio		G./tex	
Carolina Queen	1,200	1.13	47	4.8	18.1	123
Stoneville 213	1,187	1.10	46	4.9	17.5	118
St. 508-9117	1,168	1.18	45	4.1	18.6	133
Mo. 61-470	1,098	1.15	47	4.6	19.7	131
TH 149	1,098	1.17	47	4.5	21.1	146
Hopicala	1,092	1.13	49	4.4	22.6	151
Deltapine SL	1,090	1.14	46	4.9	19.0	123
Coker 413	1,032	1.21	46	4.2	19.6	141
Deltapine 523	987	1.13	50	4.9	20.8	142

[1] 50-percent span length divided by 2.5-percent span length.

and are favored by the mills, we could be on the verge of great changes in the quality of cotton produced in the Southeast and Midsouth.

Breeders in the High Plains area of Texas and Oklahoma are also concerned about fiber quality. In 1966, they organized a quality cotton variety test which has been made a part of the system of regional cotton variety tests. In 1966, hail destroyed several tests, but preliminary data from surviving tests indicate that staple length and strength of cottons adapted to the area are possible.

A partial adaptation of data reported by L. L. Ray and A. D. Hill of the Lubbock Station are given in table 4.

Paymaster 111 is being grown on considerable acreage. As breeders evaluate their material, the possibility that improved quality for the Plains may be feasible.

Two new varieties of extra-long staple Pima cotton have been released. Pima S-3 is particularly well adapted to the high elevations of the Trans-Pecos area of Texas and New Mexico. Pima S-4 is well adapted to the low elevations of Arizona. Research has shown that the fruiting height of Pima cotton is influenced considerably by warm nights of the low elevations and by the cooler night temperatures at the high elevations. In general, Pima S-4 plants would be too short in New Mexico and Texas and Pima S-3 plants would be much too rank in Arizona. When grown in the proper area, both varieties place fruit at a desirable

Table 4. --Quality cotton variety test, Welch, Tex., 1966[1]

Variety	Yield of lint	Span length 2.5 pct.	Length uniformity 50/2.5[2]	Fineness micronaire	Yarn strength
	Lb./acre	In.	Ratio		P.s.i.
Lockett 4789	788	1.12	46	3.4	75.0
CA 564[3]	737	1.10	45	3.7	93.4
Rilcot N2[3]	667	1.12	44	3.8	88.9
Paymaster 111	661	1.09	45	4.1	83.3
Gregg 35	650	.97	45	3.8	89.7
Lankart 57	531	1.04	43	3.7	74.6

[1] Partial adaptation.
[2] 50-percent span length divided by 2.5-percent span length.
[3] Experimental strains.

height for machine harvesting. Both varieties have fiber length averaging 1/32-inch longer than Pima S-2.

Disease Resistance

Diseases of cotton continue to cause serious losses. Breeders must consider the problem of resistance in the development of new varieties. The most troublesome diseases are the wilts, boll rots, and the seedling disease complex.

Verticillium wilt has been an increasing problem in the West for many years. The efforts to develop tolerant varieties have continued and most Acala varieties now have some tolerance. Higher levels of tolerance are needed, particularly in New Mexico and the northern part of the San Joaquin Valley of California. Verticillium wilt is also increasing on the High Plains; is a problem in the Upper Mississippi Delta; and is on the increase in the mid-Delta. The Southeast still is faced with the fusarium wilt-nematode complex. Bacterial blight resistance is available and is proving to be useful in most areas. The traditional approach to disease resistance has been to screen cottons by growing them in fields known to be infested. Resistant or tolerant selections were crossed with agronomically desirable but susceptible stocks, in the hope that good resistance segregants could be selected from survivors in the infested fields. Progress has been made this way, but basic research has provided more precision in breeding for disease resistance. Instead of relying on natural field infections, techniques have been developed for culturing the casual organisms, controlling the inoculation, studying the host-pathogen interaction, and conducting the tests in a controlled environment. Work of this sort now allows breeders to utilize known genes for specific races of bacterial blight. The inheritance of resistance to fusarium wilt is fairly well understood now, and screening for nematode resistance is giving more precise information than formerly. Disease resistance has been taken into consideration in developing virtually all new varieties.

Adaptability for Mechanical Harvest

This country during the past 25 years has undergone a revolution in harvesting--from handpicking to either spindle or stripper machines. Machine harvest results in a delay in beginning operations and a longer exposure to weather losses. The storm-proof or storm-resistant boll was the answer to this problem for strippers.

Research at Texas A&M University has demonstrated the benefit that can come from tightening the bolls in reducing pre-harvest losses and harvesting losses for spindle machines. Breeders are avoiding big, loose bolls. They are tending to favor quick fruiting, early maturing types. They are studying plant growth, internode lengths, and selecting for types which do not grow too rank and lodge on fertile soils. Ideally, they would like to reduce overall plant size without sacrificing fruiting positions.

As new varieties are released, I believe we can expect them to be more suitable for machine harvest than varieties bred before the switch from hand to machine harvest.

Glandless Breeding

Most of you are probably aware of the problem that gossypol causes the cottonseed crushing industry. Gossypol is the main substance in the pigmented glands so prominent in cottonseeds. It lowers the nutritive value of cottonseed meal; it can be toxic to swine and poultry; and it discolors cottonseed oil. Breeders can eliminate the glands and reduce the gossypol content of cottonseed to virtually zero. The production of glandless varieties would eliminate gossypol related problems of the crushing industry, and could make cottonseed products an important source for human consumption. This could be very important in the search for food sources in protein deficient areas of the world. Glandless cottonseed is an important and worthwhile objective.

Glandless strains of cotton have been bred which perform very well in comparison with glanded checks. So why are we not producing glandless cottonseed in quantity? Speculation on this question would require considerable time. A brief answer is that breeders are faced with the need to pursue many objectives--yield, earliness, machine harvest efficiency, fiber quality, and disease resistance. While most breeders have glandless breeding programs, they have not abandoned glanded breeding for all these other objectives. Glandless strains may not be particularly inferior to glanded checks, but so far they have not excelled. The lack of a definite economic motive for longer and stronger fiber gives glandless breeding a lower priority. Doubtless, glandless seed would bring a better price than glanded; the price differential has not yet had a chance to be established. Also, competition between glandless and glanded varieties does not now exist. A sense of urgency for releasing glandless varieties will not develop in most breeding programs until the spur of competition is felt.

An interesting development in 1966 was the production of about 15, 000 acres of Gregg 25V on the High Plains of Texas in 1966. To my knowledge, Gregg 25V is the first commercially produced glandless variety. Unfortunately, it suffered from an early freeze, the same as other varieties this past season. It remains to be seen whether the variety will gain in popularity with growers.

In conclusion, I believe cotton breeding is now in a very dynamic situation. Breeders are striving to improve yields, combat diseases, contribute to more efficient machine harvest, and improve the quality of the fiber and seeds. As advances are made, new varieties are released. If you follow the releases announced by public and private breeders, you know that rapid changes in the varieties planted are taking place. We expect these changes to lower the cost of producing cotton, improve the quality of cotton and cottonseed, and make them more competitive and useful as textile raw materials and as feed and food.

THE IMPACT OF RESEARCH ON GEORGIA'S PEANUT ENTERPRISE

by
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In 1951, the National Fertilizer Association published a symposium entitled "The Peanut, The Unpredictable Legume." The title referred to the unpredictability of the plant's response to fertility and cultural practices. It might well have referred to its unpredictability as an economic factor in the peanut producing area's agricultural economy.

In 1916, Georgia planted 40, 000 acres of peanuts. At that time, it produced a cash farm income of $1, 853, 000 and was as highly valued as a hogging-off crop. By 1965, the crop had become the State's No. 1 cash crop and produced over $100 million income.

The peanut's rise to Georgia's No. 1 cash crop has been a remarkable story of dedicated and cooperative research on the part of a number of scientists. Scientists have crossed discipline and State-lines to weld a solid story of remarkable value of research and its application.

Varieties

Early varieties of peanuts produced in Georgia probably contained more productive potential than the then accepted cultural practices were capable of producing. However, much early work was in variety development, including some farmer selection of what appeared to be superior nuts, which may have been the result of a chance cross or mutation.

Of the six varieties included in trials at Tifton in 1921, two were still in test in the late 1940's. One of these, the small Spanish, was replaced between 1946 and 1950 by the Dixie Spanish, the latter with a yield advantage of about 10 percent. About the same time, early maturing Dixie Runner began replacing N. C. Runner. These two newer varieties were released by Georgia and Florida Agricultural Experiment Stations, respectively.

During the 1950's, Argentine Spanish, a Plant Introduction from Argentina, and Early Runner, a product of W. A. Carver's breeding program in Florida, became available. Because of their high productive capacity, these varieties were readily accepted by Georgia growers. In more recent years, Starr Spanish, released by the Texas Agricultural Experiment Station in 1961 and having about the same productive capacity as Argentina, was introduced in Georgia.

In 1961, Dr. Carver's Florigiant was released by the University of Florida. It is an outstanding large-podded variety and currently is the most widely grown large-podded peanut grown in Georgia.

Diseases

Georgia researchers have long recognized that one of the many factors tending to limit the yield of peanuts was the disease problem. Both seed and plant disease problems were recognized rather early in the history of this emerging enterprise. For at least 40 years, the two diseases, Sclerotium rolfsii and Cercospora leafspot were by far the two most important diseases of the plant.

Early researchers, including B. B. Higgins and later his understudy, Wallace K. Bailey, recognized that one of the most serious peanut diseases was the soil-borne disease of Sclerotium rolfsii. Early work by Dr. Higgins developed much of the life cycle of the disease. Much of his rather basic work lay at least semidormant until L. W. Boyle, also of the Georgia Experiment Station, determined that this disease developed on plants under two ideal conditions:

(1) Partly decaying plant residue on the soil surface and in the immediate topsoil upon which the disease could survive and multiply.

(2) Injured and decaying plant tissue at, or near, the soil surface through which the disease could enter and in turn injure other tissue upon which it could feed. (The injured tissue into which the disease makes its first plant entry could be the result of other diseases, from insects or cultural tool injury.)

Based on this knowledge, Dr. Boyle concluded and proved that in the absence of preceding crop litter at or near the soil surface, the disease Sclerotium rolfsii presented no unsurmountable problem in obtaining increased peanut yields. While others have cooperatively contributed a great deal to our now rather effective techniques for controlling Sclerotium rolfsii, Dr. Boyle developed the basic "control by management" technique.

Cercospora leafspot, a disease that frequently causes heavy defoliation of peanuts in the early stages of maturity, was another disease of serious economic concern. While both Dr. Higgins and Mr. Bailey worked with this problem also, so did Naomi Woodroof and S. A. Parham of the Coastal Plain Station. Mrs. Woodroof's work, along with the published study on the several stages of the Cercospora leafspot pathogens of Wilbur Jenkins in the 1940's, is still considered the classical work done on this disease.

By 1945, the sulfur and copper-sulfur dust control were fairly well developed and have been widely used for the past 20 years. Several years ago these researchers developed more satisfactory leafspot controls by working out techniques and schedules for Maneb dust and copper sprays.

Seed-borne diseases have long been a source of stand problems for peanut growers. Satisfactory disease control without significant chemical injury to seed has long been the goal of pathologists working on this problem. In the early 1950's, 2 percent Ceresan, Arasan, and Panogen were widely used. Although they were generally successful and acceptable, they did not appear to be the final answer. In more recent years, Curtis Jackson, pathologist, Georgia Coastal Plain Experiment Station, has worked out more acceptable, and now widely used, seed-borne disease control methods with Ceresan-Captan mixture. Dr. Jackson's work, as has others, points out the importance of starting with good, sound seed, handling them properly, and applying chemical treatment properly.

During the past decade, the absence of great losses from white mold and a gradual change in cultural and harvesting practices have brought to the foreground many old and some new problems. It seems a characteristic of advancing society to expect a gradual, closer approximation to perfection in all things touched by science. Problems that once were unnoticed or tolerated become intolerable in absence of greater problems. In 1961-62, Aspergillus crown rot of seedlings decimated some Georgia fields. Jackson, after several years' research, developed a seed treatment by using a combination of fungicides that eliminated the threat of this disease and several other seed-borne problems. Durham C. Bell, also of the Coastal Plain Station, is continuing this work in an effort to find a seed treatment material that is equally effective but less toxic to the seedling and to humans.

The prevention of development of aflatoxins in peanuts on the farm is the subject of major concern at Tifton now. After 3 years' research on this problem, it appears that solution of the problem will come through a summation of efforts of all scientific and technological fields involved in peanut production and use.

Insects

It is probably axiomatic that producers' concern over the damage of diseases and insects to crops appears to increase geometrically with an arithmetic increase in either the price or yield of a high value crop. A 10 percent insect damage to a crop producing a gross of $50 to $75 per acre does not appear to create much interest. But the same percent losses to a crop grossing $200 to $250 per acre is of immediate concern. So it has been with peanut field insects in recent years. Some areas have received heavy damage from infestations of the Southern corn rootworm and to a lesser extent, the lessor cornstalk borer.

Field methods for the control of the Southern corn rootworm have been worked out by Loy Morgan, while his associates, Drs. Mitchell and Chalfant, all of the Georgia Coastal Plain Station, are conducting a study of the biology of this insect in relation to its occurrence in southwestern Georgia.

The lessor cornstalk borer, a soil-inhabiting insect which feeds on peanut foliage, occurs sporadically. However, it is a very serious insect when it does occur. Both chemical and biological control studies are now underway.

Weed Control

The mechanical control of weeds and grasses in peanuts has not only been generally unsatisfactory and expensive, but it has confounded the disease problem (Sclerotium rolfsii) by creating mechanical damage to the plant and thereby providing a point of entry for diseases.

Research in chemical weed control dates back to the early 1950's. The early work was conducted by Hauser and Thompson at the Georgia Experiment Station. Later, Hauser was transferred to the Coastal Plain Station whereupon a rather intensive USDA-State cooperative peanut weed control program was undertaken. Later, additional support was given by the Georgia Agricultural Commodity Commission for Peanuts. This work has been conducted largely by Ellis Hauser and S. A. Parham.

Many weed and grass problems face Georgia peanut growers, the most serious of which is nutgrass or nutsedge. Some early chemical treatments for weed control were promising but not outstanding, and grower acceptance was slow. The turning point in the Georgia herbicide research program was in 1959, when mixtures of herbicides were first used in peanut production at Tifton. Work with mixtures showed that when residual preemergence herbicides, such as sesone, were mixed with DNBP and application was delayed for 6 days beyond the preemergence stage, the consistency of weed control markedly increased. The use of mixtures also permitted lower rates of individual chemicals, thereby reducing potential peanut damage and residue hazards in soil. The wide acceptability of the herbicide mixture concept by the Georgia peanut farmer is demonstrated by the rapid increase of farm application. Before 1955, acreage of peanuts treated with herbicide varied from less than 1 to 12 percent. Annual acreage of peanuts treated with herbicides since that time has been as follows:

Year	Approximate acres treated	Approximate percent of total acreage
	Thousand	
1955	3	1
1956	20	5
1957	60	12
1958	35	7
1959	18	4
1960	50	10
1961	100	20
1962	200	40
1963	270	54
1964	350	70
1965	395	79
1966	400	86

The vast majority of these acreages were treated with mixtures and technique developed at the Coastal Plain Station.

But adequate control of all weeds except nutgrass (nutsedge) left the latter pest with little competition and it expanded rapidly. Not only was there less competition with other weeds, but changes in cultural practices led to less cultivation. Thus even less restraints were put on the multiplication of nutgrass.

Research at Tifton and elsewhere from about 1958 to 1962 indicated that the thiocarbamate herbicides applied as preplant incorporated treatments were promising for nutsedge control. However, results on both nutsedge control and injury to the crop were inconsistent. Beginning in 1962, greenhouse and field studies were conducted at Tifton to improve the consistency of the herbicide vernolate both with respect to improved weed control and safety on peanuts. The 1962 and 1963 experiments showed that subsurface placement of vernolate in discrete layers beneath the soil dramatically improved nutsedge control but also increased injury to peanuts. Later research to improve crop tolerance pinpointed the injection and sweep placement methods as offering excellent possibilities for substantially improving crop and yet maintaining excellent weed control. In fact, the new methods appear much safer, in terms of early plant damage than does the incorporation practices which are standard at the present time.[1/]

Nutrition

Many peanut nutrition problems are yet to be solved. In general, all nutrition work with this crop indicates that it is an efficient user of residual fertilizer and of the basic plant food elements naturally occurring in soil. As compared to other crops of the area, only light applications of fertilizer are profitable (Parham and Carter). However, to meet the calcium requirements of the large podded varieties, and sometimes Runner and Spanish, an application of gypsum is necessary.

Research by Carter and Walker (Coastal Plain Experiment Station) now in progress, is attempting to answer some basic questions on the role of minor elements in the nutrition of peanuts. Some preliminary data indicate that minor element nutrition problems may be associated with some heretofore unexplained conditions as hollowheart and kernel discoloration.

Mechanization

The development of tools and techniques for the proper application of information developed in the several other areas of research has been one of the important steps leading to the recent marked increase in the average farm yield of peanuts in Georgia. While many phases of peanut research have been segmented into the several research disci-

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[1/] The injection and sweep methods are still classed as experimental. These methods of application have not yet been approved by Food and Drug Administration.

plines, much of it has been interdiscipline research. The application of the research has been tied to the tools and techniques that have tied all the involved disciplines into efforts with Agricultural Engineering.

The Coastal Plain Experiment Station's Engineering Department was established in 1946. The first problem involved research to develop a practical peanut combine. From 1946 to 1949, many of the basic concepts used in the modern combine were built into a combine by James Shepherd. The successful use of the peanut combine is demonstrated by its wide acceptance.

But, as combining of peanuts was accepted and expanded, satisfactory drying equipment and techniques had to be developed. Here, too, the Coastal Plain Station's work and recommendations, including portable wagon and tobacco barn-type systems, have been the basis for wide adaptation and rapid increase in drying facilities in Georgia. The development of the combine, satisfactory plows, shaking equipment, and drying equipment has eliminated hand stacking and threshing separation and thereby saved millions of dollars in labor and peanut harvesting loss reduction.

Following the development of the combine and related tools and equipment to maximize the effectiveness of its use, the Engineering Department began a systematic and interdepartmentally coordinated program of equipment development to maximize the effectiveness of the rapidly developing information in other areas of research.

To effectively control Sclerotium rolfsii on a farm production basis required economical and practical farmer-acceptable tools for accurately controlling the deep burial of crop residue. Mr. Shepherd attacked this problem and successfully produced such a tool. It consists of an angling colter mounted in front of the turning plow in such a way as to "slice off" about 3 inches of the litter bearing topsoil, throwing it into the previous plow furrow. This resulted in the litter being buried 3 to 5 inches and far below the feeding zone of the disease.

But this did not solve all the problems with this disease. Normal cultural practices would plow much of this buried litter back up to the surface and would, therefore, be self-defeating. In attempting to solve this and other problems, Mr. Shepherd developed what he referred to as the "package plan" of peanut production, which required a close adherence to a rather rigid and precise system of land preparation and crop handling. Thus, an entirely new peanut production concept has been developed which, in its varying degrees of farm application, has essentially revolutionized peanut production in Georgia. This new concept--the results of many years of research by many scientists--is essentially as follows:

(1) Thorough shredding and discing crop residue in preparation for land turning.

(2) Pre-turning application of fertilizer.

(3) The use of precise fitting accurately "angled" concave disc coulters to moldboard plows for effective deep burial of residue litter (help control diseases as well as grass and weed populations).

(4) By using specially designed clod-breaking attachments with (or directly after) the plowing, avoid the expense and detrimental practice of harrowing after turning.

(5) Practice "wheel tracking" and bed forming as a base of accurate control in all subsequent steps in mechanized production.

(6) Where necessary, use special tools for "bed cultivation," in lieu of harrowing, to control weeds before planting.

(7) In heavily infested nutgrass fields, incorporate into the topsoil recommended weedicide mixtures.

(8) Use carefully treated high quality seed.

(9) Adjust seeding rate to be compatible with seeding rate for row pattern used (4-row or 2-row pattern).

(10) Use preemergence or "cracking stage" chemical weed controls.

(11) Minimize cultivations, maintain the originally formed bed.

(12) Follow an adequate program of insect and leaf spot control.

(13) Especially where vines are heavy, remove vine tops as an aid in harvesting.

(14) Use plow-up tools, windrow shaker, and combine in the best prescribed manner, and, if needed, only supplemental heat to harvested nuts to reduce to safe moisture level.

Coordinate Research Program Pyramids Results

Peanut production research has paid handsome dividends in Georgia. The progress was slow in the early years of the crop's history in the State. Little change was made in the State's average yield from the time it began to be of commercial importance until 1930. For the next 25 years (1955), Georgia's average yield increased less than 50 percent while the past 12 years have seen almost a 100 percent yield increase.

But the full story of the success of peanut research is not measured in increased yields alone. The reduction in labor requirements has been just as significant as yield increase. For the most part, the world's 43 million acres of peanuts are produced entirely by man labor. A research report by Great Britain (in Senegal, Africa) reveals that the following man-hours are required to produce an acre of peanuts by the methods indicated:

	Hours
(1) Full man labor	192
(2) Oxen plus man labor	140
(3) Partly mechanized	61
(4) Fully mechanized	12

Georgia scientists have estimated that man-labor requirement per acre of peanuts (including the setting up of equipment) is 15 hours.

There is no question but what the overall effectiveness of Georgia's peanut research program has been materially increased through the coordinated efforts of scientists in the several research disciplines. Here is the story in annual per acre yields:

Year	Yield/Acre
1925-29	589
1930-34	598
1935-39	710
1940-44	716
1945-49	704
1950-54	846
1955-59	1,043
1960 [1]	1,200
1961	1,200
1962	1,130
1963	1,530
1964	1,670
1965	1,810
1966	1,700

[1] Yield for 1960—66 is net weight basis.

THIRD SESSION: V. H. McFarlane, Southern Utilization Research and Development Division, ARS, USDA

PROCESSED SOY PRODUCTS

by

Robert J. Dimler, Director
Northern Utilization Research and Development Division

I am pleased to bring you greetings from the Northern Utilization Research and Development Division (NURDD), and also from the State Experiment Stations of the North Central Region. Not too many years ago, I would have also said that I brought greetings from "Soybean Country." But today, the Southern and North-Central Regions have joined hands in soybean production.

In discussing products from soybeans, I shall limit myself to food uses. The need for food in many countries looms large today and in the future. Export opportunities for soybeans based on food uses, therefore, are important.

Among processed products from soybeans, I shall mention some that have resulted from industrial efforts. I also intend to comment on several areas with which we are concerned at the NURDD in Peoria, Ill.

The use of soybeans, as such, for human food generally has been limited to the Orient. In contrast, the oil of soybeans has been a very important food product for the United States, particularly in the form of shortening and margarine. The protein portion of the bean, however, has generally gone into animal feed. Increasing attention is now being given to the use of soybeans as a protein source for human feeding. The immediate emphasis is on the export market for which new high-protein foods from soybeans have considerable potential. While cash markets are expected to be the ultimate goal, particular concern at the moment is for Food for Peace and related markets directed toward helping others.

The opportunities for increased use of oil from soybeans in the food market, of course, must not be overlooked. Research directed toward improving the flavor stability of soybean oil is important for both domestic and foreign markets.

World Food Needs. --Let us consider world food needs for a moment. The protein needs have been given considerable publicity. Worldwide, the protein deficit by 1970 is predicted to reach 9. 7 million metric tons when expressed as fish and dry beans and peas as shown in table 1. This tonnage includes allowance for a modest increase, roughly 10 percent, in the supply of cereal grains. If this protein deficit is translated into soybean equivalents, a total of 420 million bushels of soybeans would provide the amount of protein needed. Of course, we do not expect that soybeans alone would fill this need, but the 420 million bushels gives us a frame of reference in terms of the commodity on which we are centering our attention.

Table 1. --World protein deficit, 1970[1]

World Commodity	Million metric tons	Million bushels soybeans
Fish	3. 0	240
Dry beans and peas	6. 7	180
	9. 7	420

Source: From The World Food Budget, 1970 - USDA, 1964

A deficit exists, not only of protein but also of fat, according to the information published in the World Food Budget. The total fat deficit expected for 1970 is about 3 million metric tons. In terms of soybeans, this tonnage would be equivalent to 630 million bushels of soybeans. If we were to consider only soybeans for meeting these two deficits, 420 million of the 630 million bushels would take care of the protein deficit. Theoretically, we see that more soybeans would be required to meet the fat needs than the protein. Further comment on these interrelationships probably would not be justified since one would expect alternative sources of fats and proteins to come into the picture.

The potential contribution that soybeans could make to meeting the needs for both protein and fat directs our attention very quickly to the entire soybean rather than to its two major components. Therefore, part of our research effort has been concerned with food uses of essentially the entire bean, retaining all but the hull.

Commercial Soybean Protein Products. --Soybean protein is available commercially in four main forms: Defatted soy flour, full-fat soy flour, protein 70, and isolated soy protein. Data on the chemical composition of these products are given in table 2. The effect of processing in the preparation of these different types of product is indicated by the differences in protein, fat, crude fiber, oligosaccharides, polysaccharides, and ash. The oligosaccharides are included because we believe that they may be related to physiological characteristics (flatus production) of soybeans. The polysaccharides are almost indigestible.

In full-fat soy flour essentially all the bean, except the hull, is retained. While this flour has relatively limited commercial importance at present, we do believe that it is likely to receive increasing attention. Experimental studies at NURDD on preparation of full-fat soy flour will be discussed in detail a little later.

The more common type of soy flour is the defatted product. Removal of the fat, of course, increases the concentration of the other constituents. Defatted flour is used in a number of food products because of the beneficial functional properties that it con-

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[1] Deficit of protein after 54 million metric tons (2.4 billion bushels) of cereal grains are furnished.

Table 2. --Commercial soybean protein products for use in foods

Component	Approximate analysis, in percent on dry basis			
	Defatted soy flour	Full-fat soy flour	Protein 70	Isolated soy protein
Protein [N x 6.25]	52	42	71	95
Fat [ether extract]	1	22	none	none
Crude fiber [max.]	3.5	3	3.5	none
Oligosaccharides [1]	13	10	none	none
Polysaccharides	15	12	20	none
Ash	6	5	5	3

[1] Raffinose, stachyose, and sucrose.

tributes; in other cases, the protein as such is the desired contribution.

Protein 70 brings us into the area of protein concentrates. It is made by extracting defatted soy meal with water at the isoelectric point of the protein or by extracting with 70 percent alcohol. The removal of oligosaccharides and other solubles results in a protein content of around 70 percent and an increase in the concentration of polysaccharides. Protein 70 sells for about 18 to 20 cents per pound compared with a price of 7 cents for defatted soy flour and 8 cents for nondefatted.

Isolated soy protein provides a still higher concentration of protein and contains essentially no saccharides, fiber, and fat. Such a product is prepared by dissolving the protein from the bean or defatted meal and then isolating the protein by precipitation. The cost of isolated protein is about 35 cents per pound.

Among commercial protein products the so-called textured foods merit some mention. Several companies have been doing successful research and development on the preparation of fibrous materials some of which simulate meat in texture and physical characteristics. Isolated soy protein is the starting point for some of the products. A limited amount of commercial production has occurred, and considerable experimental work is continuing on such materials. Many of you may have already encountered one or more of these protein products. Peanut butter has been marketed with soy protein chips with a bacon flavor. Foods for vegetarians, such as the Seventh Day Adventists, have been made from soy protein. These foods have the chewing and flavor characteristics of some meat products. Commercial attention is being given to the production of textured materials, not only from isolated protein but also from either the meal or a fraction of it. While we are not directly engaged in research on textured products at Peoria, we trust that our past and present basic studies on soy proteins are of value to the commercial endeavors.

Still another recently developed commercial protein product is a beverage type, which is being sold in Hong Kong. It is called Vitasoy. This product is made by extracting the whole bean or full-fat flour with water under conditions that will dissolve the protein and emulsify the fat. The resulting beverage product is very similar to milk in composition and physical characteristics.

Full-fat Soy Flour. --One of the projects undertaken at NURDD recently was the development of a simple procedure for making full-fat soy flour. The objective (fig. 1) was to use methods and equipment adaptable to local use in developing countries. The emphasis on full-fat soy flour reflected the need many people have not only for proteins but also for calories that could be supplied by the fat in the full-fat soy flour. Thus, in one "package" one could supply both protein and fat.

The steps in the process for making full-fat soy flour are outlined in figure 2. First whole soybeans are soaked for 4 to 6 hours in water of drinking quality containing added 1 percent sodium bicarbonate. While the addition of the baking soda is not essential, it does make the beans easier to cook. The soaked beans are drained, as shown in the upper left-hand picture of figure 1 and cooked in boiling water for 10 to 15 minutes. The beans then are spread out in a thin layer

Full-Fat Soy Flour Process

For Local Use in Developing Countries

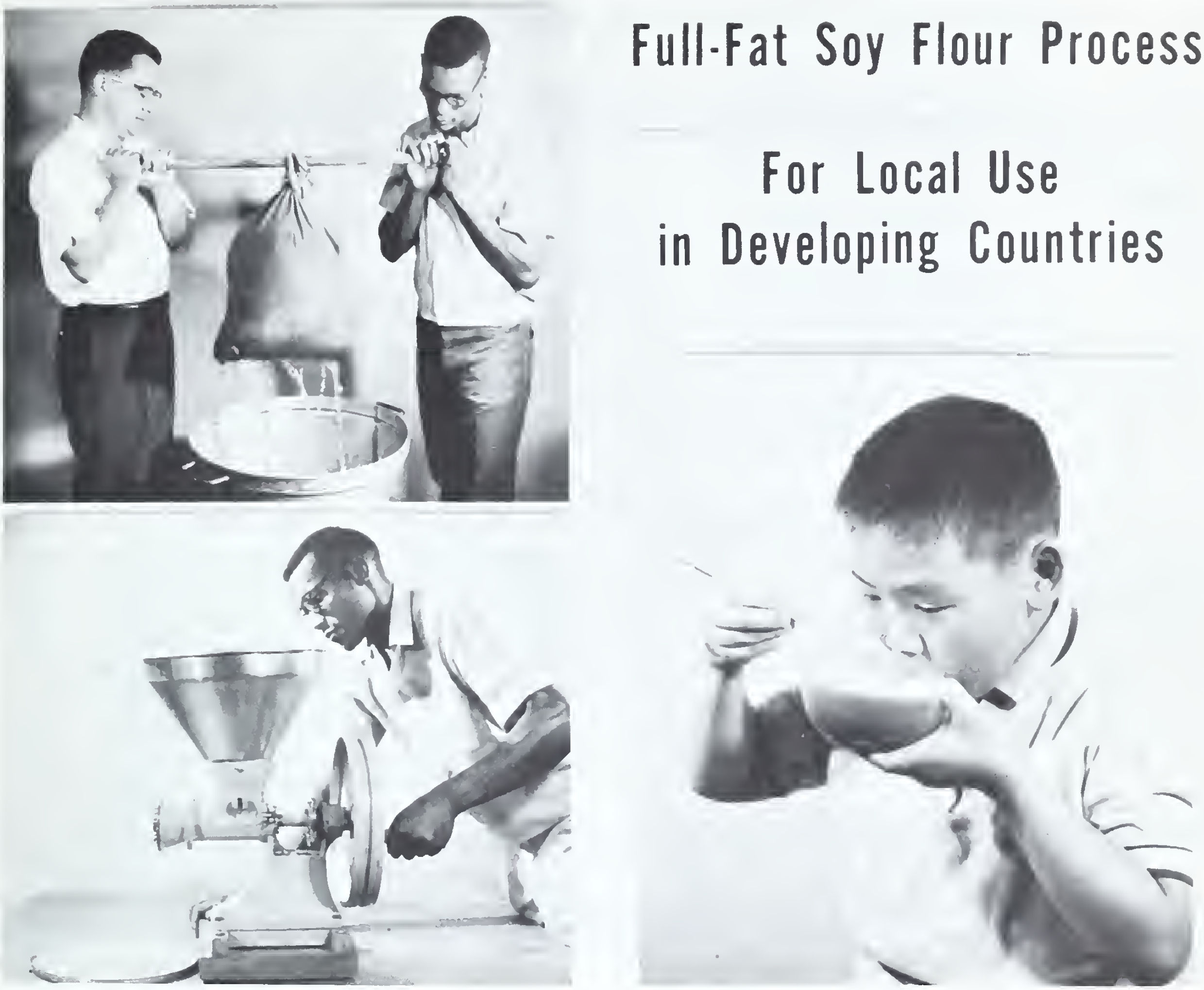

Figure 1.--Full-fat soy flour process for local use in developing countries.

and allowed to air dry to around a 10 percent moisture content, preferably in the sunshine or with artificial heat. The dry beans are put through a coarse grinder to crack them and loosen the hull. Removal of the hull is accomplished by a winnowing machine. The dehulled soybean meats then are ground in a hand grinder to the full-fat flour.

The equipment used for this process is hand operated in order to provide greatest simplicity. The cracking mill, dehuller, and flour mill can be purchased from a Japanese manufacturer for around $150. With this equipment five men can produce 300 pounds of soy flour in an 8-hour day. This amount is enough to take care of half the daily needs of protein for about 1, 600 adults.

Data on typical composition of immersion-cooked full-fat soy flour made by this so-called "village process" are given below. The protein content of 41 to 42 percent obviously provides a good basis for the use of the full-fat soy flour as a protein supplement. Such a use is even more attractive when one considers that the amino acid composition of the soy protein complements that of cereal

	Percent
Protein	41 to 42
Crude fat	20 to 23
Ash	5 to 7
Moisture	6 to 8
Crude fiber	2. 5 to 3. 0
Urease activity, pH change	0. 0
Nitrogen solubility index	15 to 20
Available lysine	6. 0 to 6. 5

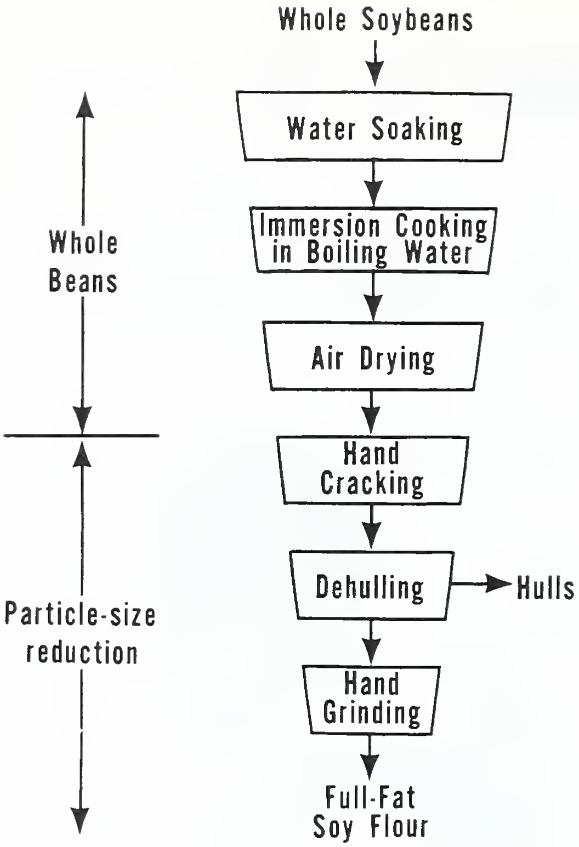

Figure 2.--Flow diagram of village process for full-fat soy flour.

grain proteins to give a combination which has a better balance of the essential amino acids than do either of the constituents. From this standpoint, the available lysine content of 6. 0 to 6. 5 percent is particularly significant since cereal proteins generally are deficient in lysine.

The oil in the flour (crude fat, 20 to 23 percent) is important as a source of both calories and essential fatty acids. Retention of the oil in the flour, of course, is necessary for greatest processing simplicity. Despite its high fat content, the flour appears to have good keeping quality, probably because of natural antioxidants together with the inactivation of lipases and lipoxidases by cooking.

Effects of the cooking step are reflected in the urease activity and nitrogen solubility index. Reduction of urease activity to zero indicates that cooking is adequate to destroy antinutritional factors that are present in soybeans, just as they are in many other raw food materials. At the same time, overcooking is avoided in order to maintain a relatively high nitrogen solubility index, which drops with denaturation of the protein.

Some indication of the practical importance of the cooking step is given by data on rat feeding studies in figure 3. The increase in protein efficiency ratio (ratio of weight gained to protein eaten) with increasing autoclaving time is a result largely of the destruction of trypsin inhibitor and possibly other antinutritional factors. The heat treatment is more effective at the higher moisture content of 19-percent than at 5-percent moisture. The protein efficiency ratio of about 2. 0 reached by curve B is very good when one considers that casein, which is the standard of reference, has a value of 2. 2 in these studies.

Extrusion Cooking. --We also are conducting studies on a more refined and larger scale type of process for preparing full-fat soy flour. The process incorporating the use of an extruder-cooker is outlined diagrammatically in figure 4. The starting material is the whole soybean. However, in contrast with the village process, cracking and dehulling beans is done before instead of after cooking. The grits may either be flaked first or put directly into the preconditioner in which moisture is added. From the high-speed mixer the material goes into the extruder-cooker in which the combination of pressure and added heat builds up sufficiently high temperatures to give the proper degree of cooking. The extruded material is cooled and ground to the desired full-fat flour.

The output end of the experimental extruder we have in our pilot plant at the NURDD is shown in figure 5. As the material is forced out of the orifice, it expands somewhat and breaks into chunks, shown in the operator's hand and in the receiving tray. These then are readily ground to produce the flour.

Corn-Soya-Milk Mixture. --In his discussion, Dr. Senti mentioned that the U. S. Department of Agriculture is purchasing a formulated material called CSM (corn-soya-milk) mixture for use in the Food for Peace program. The composition of Formula No. 2 of this blended food product is listed below. The mixture consists of partly gelatinized cornmeal (68 percent), adequately cooked toasted defatty soy flour (25 percent), nonfat dry milk solids (5 percent), and

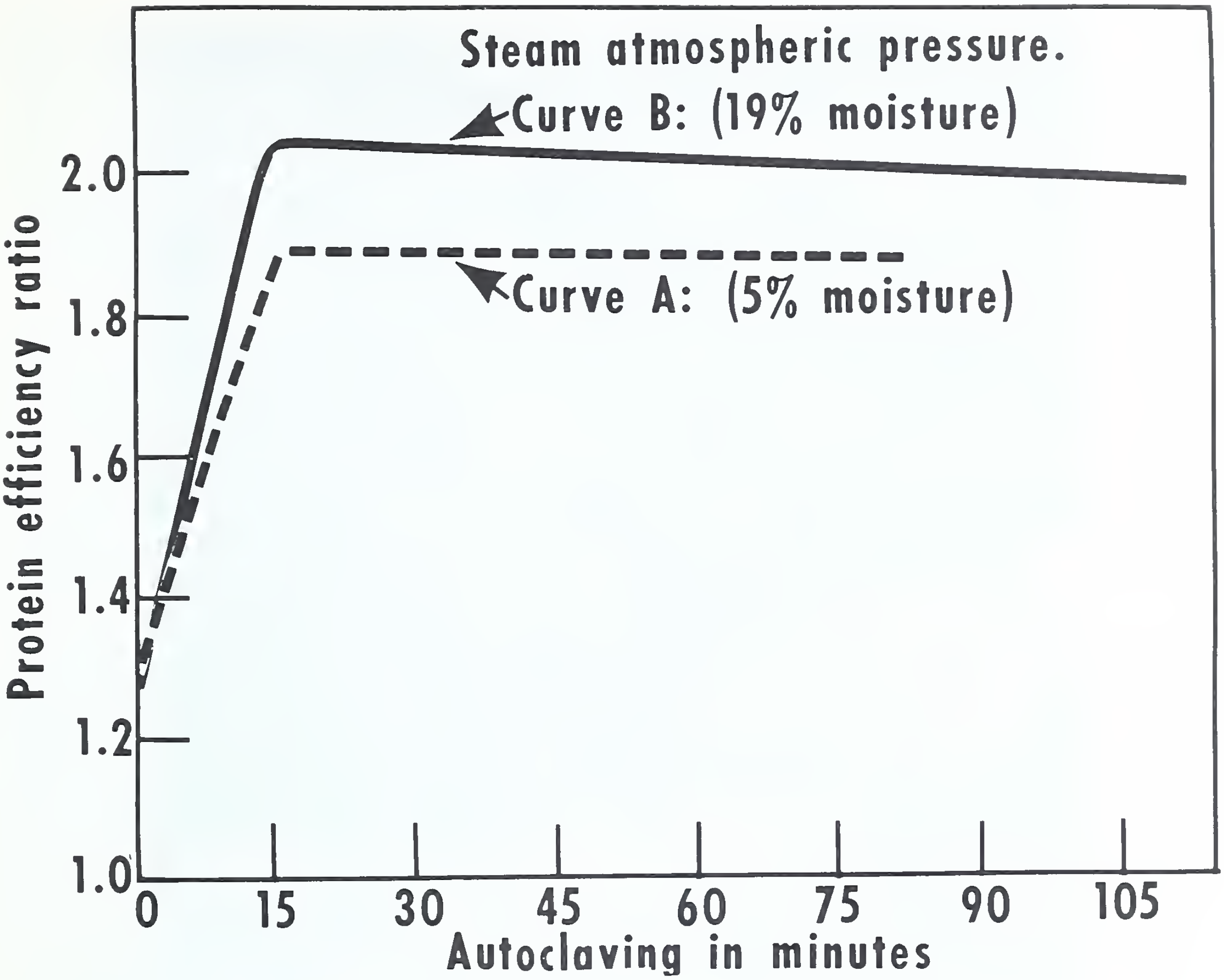

Figure 3.--Change in protein efficiency ratio with heating of soybeans at two moisture levels.

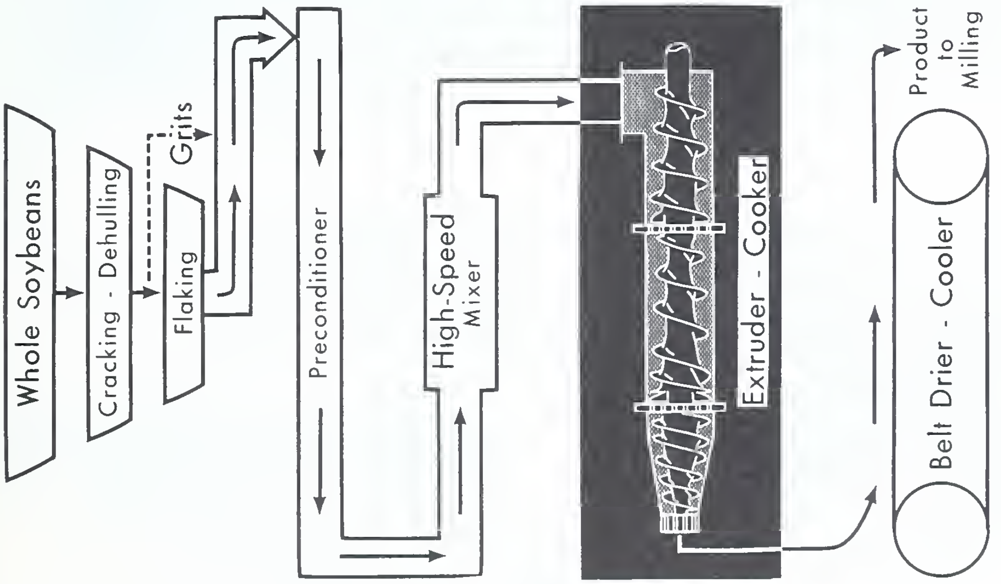

Figure 4.--Flow diagram of extrusion-cooking process for full-fat soy flour.

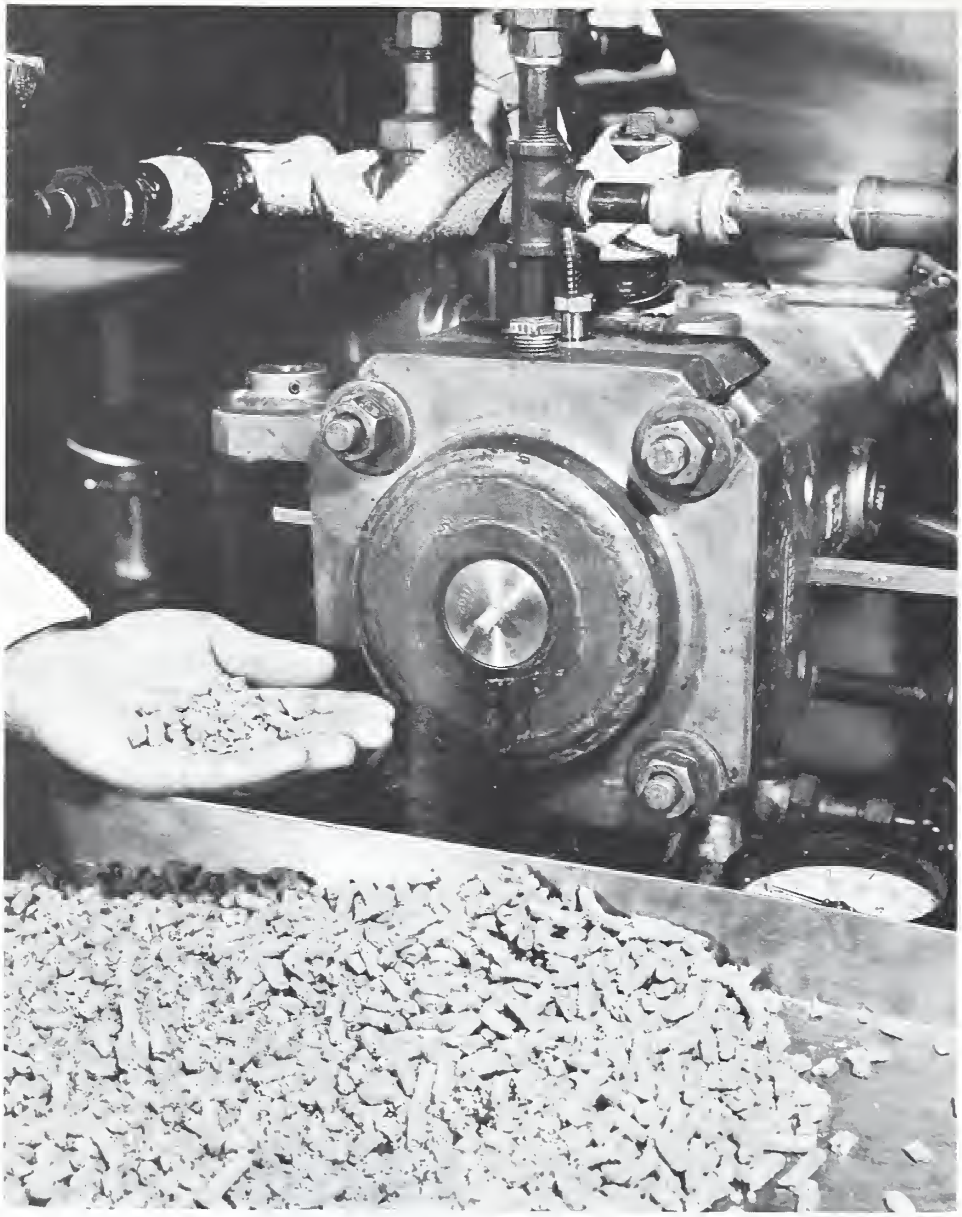

Figure 5.—Extrusion-cooked full-fat soy product coming out of orifice of extruder.

minerals and vitamins (2 percent). The makeup of the mixture is adjusted to give a level of 20 percent protein and 2 percent fat. While this particular formulation is intended primarily for use as a gruel or porridge, it undoubtedly can be used in many other recipes. It is light yellow in color and tastes much like a number of the cooked cereals that one encounters in the domestic market.

	Percent
Gelatinized cornmeal	68
Defatted soy flour (toasted)	25
Nonfat dry milk solids	5
Minerals and vitamins	2
	100

Nutritionally, the merit of combining soybeans and corn already has been noted. Let us look more closely at some of the critical relationships in amino acid composition for soybeans and corn (table 3). For comparison, data also are given for opaque-2 maize, one of the high-lysine types of corn, which Dr. Senti mentioned. Values are given only for lysine, methionine, and total sulfur-containing amino acids. As a base of reference, the recommended levels in the FAO-WHO provisional amino acid pattern are given in the first column.

The lysine content of normal corn is notoriously low (175 mg. /g. nitrogen) compared with the requirement for 270 mg. in the provisional pattern. In contrast, soybean meal is far above the requirement so that it complements corn in a mixture to give the required level of lysine easily. High-lysine corn, of course, is receiving acclaim because on its own it has a lysine content in the optimum region.

The total sulfur-containing amino acids are a bit low for all the commodities listed in table 3, but not seriously so. However, methionine, which is one of the sulfur-containing amino acids, is distinctly low in soybean meal protein, whereas in corn protein it is above the requirements in the provisional pattern. Thus for methionine, as well as lysine, the two sources of protein complement each other.

The protein score for normal corn is quite low (65), primarily as a result of the deficiency in lysine. The score of 93 for soy protein is good but not ideal. No attempt has been made to portray the protein score for a combination of soybean meal and normal corn. However, in view of the complementary relationships between soybean meal and normal corn, the combination obviously should have a better protein score than either one alone. The protein score for opaque-2 maize (97) is notably close to the ideal of 100 for the provisional pattern.

Cereal Tempeh.--Another method for advantageously combining soybeans and cereals is to use them together in one of the traditional oriental foods, tempeh. In the past, tempeh has been made from soybeans alone. Since tempeh is a fermented food, our attention was directed to it because of our collection of micro-organisms and knowledge of fermentation technology. We have studied the use of combinations of wheat and soybeans as indicated in figure 6. We found that various strains of the mold used in making tempeh differed in their ability to form a good quality product. Most important was our finding through animal feeding tests that nutritional value of the soybean-wheat tempeh was better than that of either of the starting materials alone.

Soybeans hold a place in other oriental foods. Among them is tofu. An important export market for American soybeans is to supply raw material for the production of tofu in Japan. For this purpose, the exporting of identity-preserved soybeans has gained prominence. The use of specific varieties of soybeans is based on studies carried out at Peoria and through the PL-480 program. Differences in the suitability of soybean varieties for tofu preparation are shown in table 4, taken from PL-480 studies under our supervision.

Soybean Oil.--Finally, a few comments should be made about soybean oil. This oil already holds a prominent position as a food product. However, it does have some limitations, particularly for use as a cooking oil. The main problem in this application is insufficient flavor stability. Part of our work at Peoria has been directed toward determin-

Table 3.--Comparison of corn and soybean proteins with FAO-WHO provisional amino acid pattern

	Milligram amino acid per gram nitrogen			
Amino Acid	Provisional pattern	Opaque-2 maize	Soybean meal 50 percent	Normal corn
Lysine	270	294	429	175
Total S	213	206	198	200
Methionine	106	119	98	125
Protein score	100	97	93	65

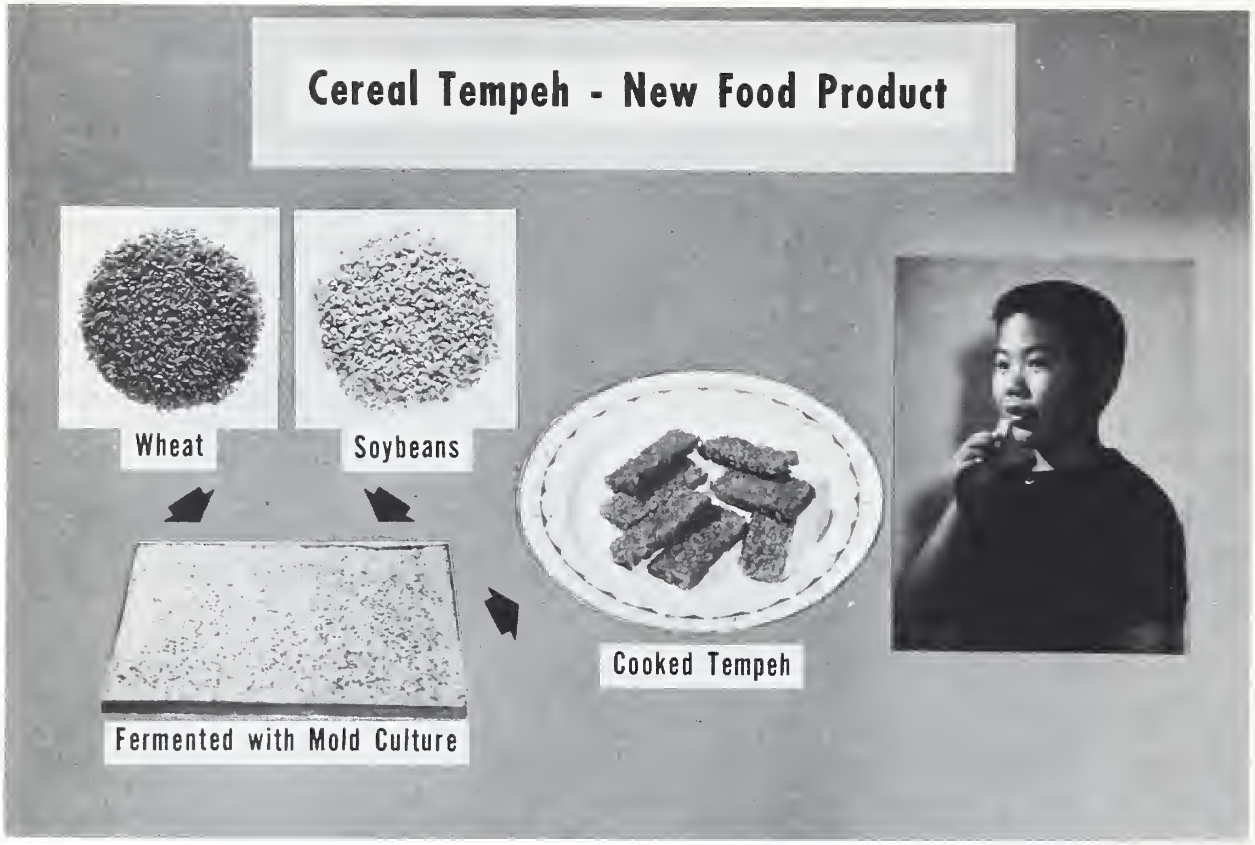

Figure 6.—Cereal tempeh — new food product.

Table 4. --Evaluation of soybean varieties for tofu[1]

Best quality and yields of tofu	Acceptable tofu	Unsuitable for tofu
Hawkeye	Jackson	Hill
Chippewa	Lee	Blackhawk
CNS-4	Mandarin	Comet
	Clark	

[1] Preliminary results from 14 factories.

ing the causes for change of flavor and the development of methods for avoiding or minimizing such changes.

The cause of flavor changes resides largely in the fatty-acid composition of the oil, especially the unsaturated fatty acids. The three main fatty acids in soybean oil are shown in figure 7. As far as flavor is concerned, the culprit is the bottom one--linolenic acid, with triple unsaturation. Although there is only about 8 percent, that level is far too great.

Two approaches have been under study for improving the flavor stability of soybean oil. One is to minimize changes by avoiding or inactivating catalysts that accelerate flavor change. The other is to selectively remove all or a major part of the linolenic acid.

Contamination by metal ions accelerates flavor change through oxidative reactions. Studies at NURDD and elsewhere have shown that improvements in flavor stability result from careful avoidance of metal contamination during processing of soybean oil. Further stabilization can be achieved by inactivating the metal ions, for example, by the addition of citrate. However, neither of these approaches offers the permanent stabilization that would be achieved by removal of the linolenic acid.

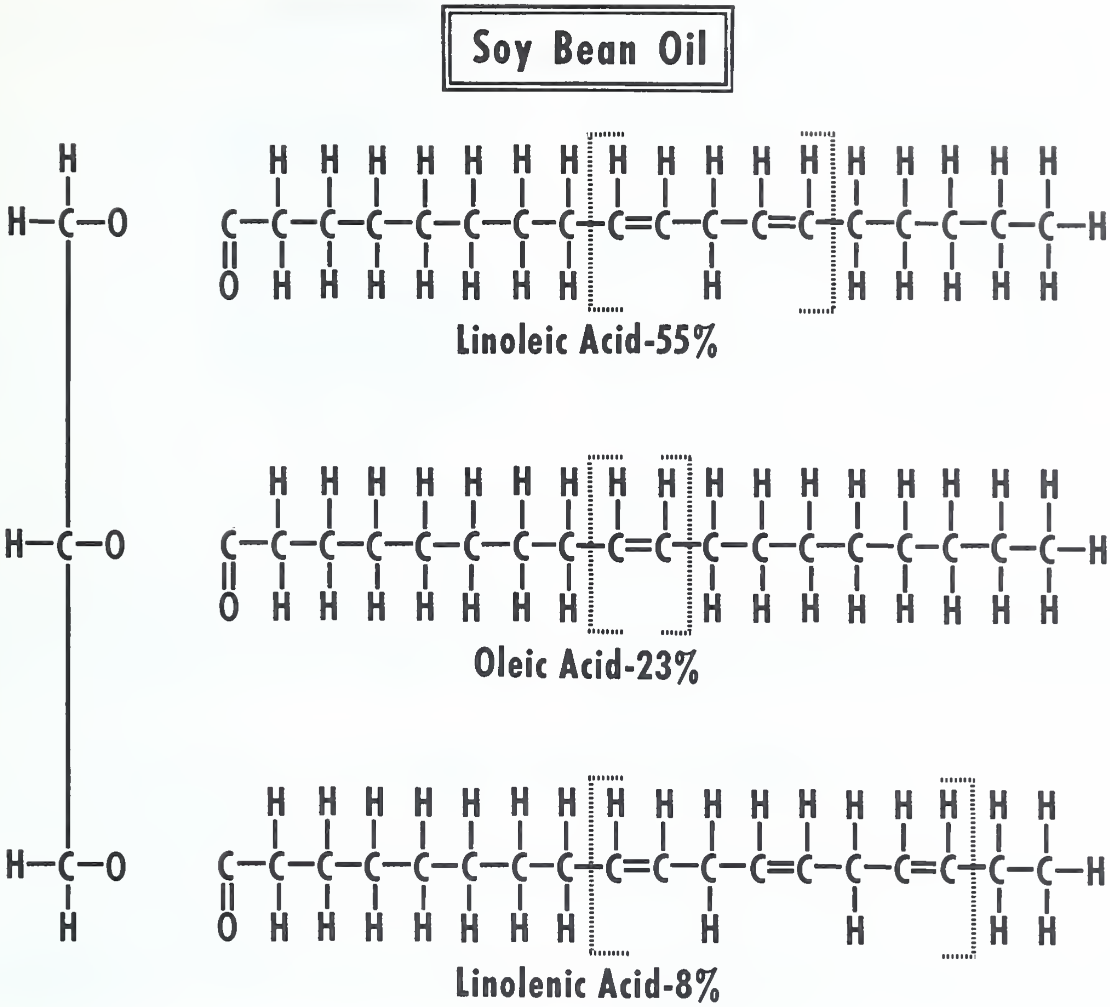

Figure 7.--Main fatty acids of soybean oil.

Elimination of linolenic acid is being approached through selective hydrogenation. The objective is to reduce one of the double bonds in linolenic acid with little or no change in the doubly and singly unsaturated fatty acids. Retention of unsaturation is essential in order to preserve the liquid character of the oil and also provide a supply of essential fatty acids for human nutrition. Reduction involves reaction of hydrogen with the double bonds, metallic catalysts being added to accelerate the reaction.

Our research on selective hydrogenation includes a study of the effectiveness of different catalysts. An indication of the degree of success we are having is shown in figure 8. The original oil had 7 percent of the undesired triply unsaturated linolenate while it had 79 percent of the combination of doubly and singly unsaturates which are desirable. When an ordinary commercial catalyst was used for partial hydrogenation, the amount of linolenate was lowered to 4 percent, but at the same time the amount of desirable unsaturated fatty acids was also lowered slightly. A much more favorable situation results from the use of our better experimental catalysts. In this case there not only was a greater lowering of linolenate content to 2 percent, but also an actual increase in the amount of desired unsaturated fatty acids. This increase comes from the conversion of linolenate to the doubly unsaturated fatty acids to saturated ones. While processing problems remain to be solved, the outlook is favorable.

Conclusion. --This review of processed soy products has, of necessity, been quite brief. I have touched on full-fat soy flour, on protein products, and on soybean oil

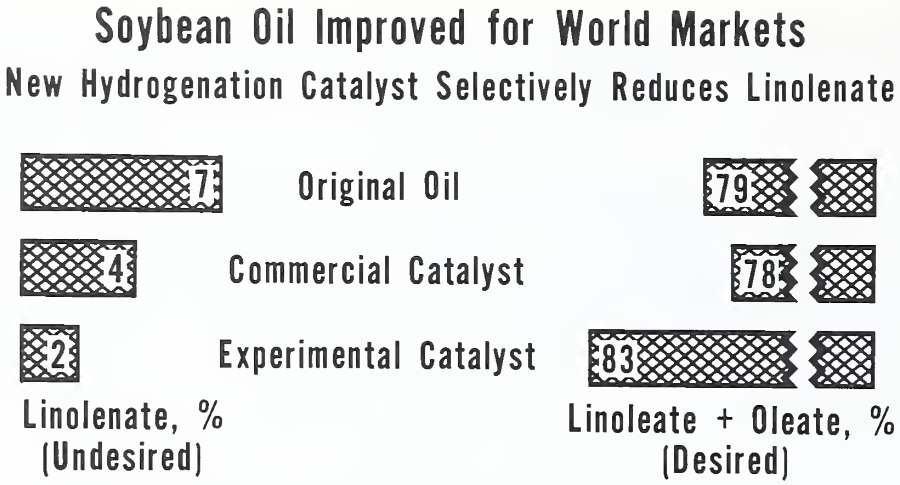

Figure 8.--Soybean oil improved for world markets. New hydrogenation catalyst selectively reduces linolenate.

(particularly as a cooking oil). In these areas, research has contributed to the food use of soybeans. However, opportunities for further progress remain. We are confident that soybeans, whether grown in the South or the north, have a great future in providing additional food for the peoples of the world.

PROCESSED PEANUT PRODUCTS

by
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In discussing processed peanut products, I will first show how the United States fits into the world peanut production, consumption, and export picture. I will then review briefly the recent research on development of peanut products at the Southern Utilization Research and Development Division (SURDD) and under outside contract.

The world production of unshelled peanuts is about 18 million tons or 36 billion pounds. Of this amount, the United States produces a little over 1.2 million tons or 2.2 billion pounds--about 6-1/2 percent of the world production.

Production in other areas of the world is as follows:

	Tons
Europe	30,000
South America	935,000
Africa	5,105,000
Asia	10,705,000

Of the total amount produced in Asia, more than half is produced in India--about 6.8 million tons.

According to the Food and Agriculture Organization (FAO) 1965 Trade Yearbook, the Europe imports of shelled peanuts amount to almost 2 billion pounds, or about 87 percent of the total world imports. Africa exports about 88 percent of the total world export of shelled peanuts. Therefore, it is apparent that most of the marketing of peanuts is from Africa to Europe.

The United States exports only about 62,000 tons or 122 million pounds, which is about 5 percent of the world export-import trade. As you can see, participation is low. Canada imports one-third to one-half of these United States peanuts and the remainder are shipped mainly to France, Belgium, Netherlands, and Great Britain.

Most of the United States exports of peanuts are through the Commodity Credit

Corporation (CCC) since the United States' peanut prices are not competitive with the world market price.

But, this does not mean that the United States peanut export market should not be explored more thoroughly. Several reasons for anticipating increased production and marketing of peanuts are given below:

(1) Developing countries will be consuming more and more of their production of peanuts in the future because of increased population and increased need for protein. Less peanuts will be available for export.

(2) Since protein content of peanuts is high, the demand for peanuts will increase, and with the fast population growth, there also will be an increased demand for high-quality protein-containing products. The potential availability of peanut-protein products as a source of food appears to be appreciable, particularly in the form of flour and protein isolates.

(3) Indication that there will be an increasing demand for peanuts is the fact that more peanut processing equipment is being installed in countries such as England and Japan. In the March issue of Peanut Journal and Nut World is an article headlined "Bauer Air Lift Helped England Meet Season's Demand for Peanuts." Bauer had shipped, by air, a complete peanut processing system to England, who purchases peanuts from 15 different countries.

The extent to which peanuts will be utilized as food, particularly for "worldfeeding," will depend largely upon the economics of producing peanuts and peanut-containing foods.

In the past 10 years, the yields per acre in the United States has almost doubled, from 928 to 1,735 pounds. This sharp uptrend in yield reflects increased use of fertilizers, herbicides, higher yielding varieties, and closer plantings. Factors such as these and the control of the quality problem may help United States' competitive position for world markets.

In the United States, the per capita consumption of peanuts had increased from 5.8 to 7.7 pounds during the past 10 years. Further increased utilization will result primarily from the development of new products that have a specific appeal such as flavor or lower calorie content. A good example of the latter is the partly defatted peanut product recently developed at the Southern Utilization Research and Development Division.

Low-Calorie Peanuts. --The partly defatted peanut product, which was first introduced commercially early last year and now produced by at least two companies, has great possibilities of being a large volume item. It is anticipated that several other companies will have this product and variations of this product on the market in the near future. For the benefit of those who are not acquainted with this new development, I would like to show a flow diagram of the process (fig. 1).

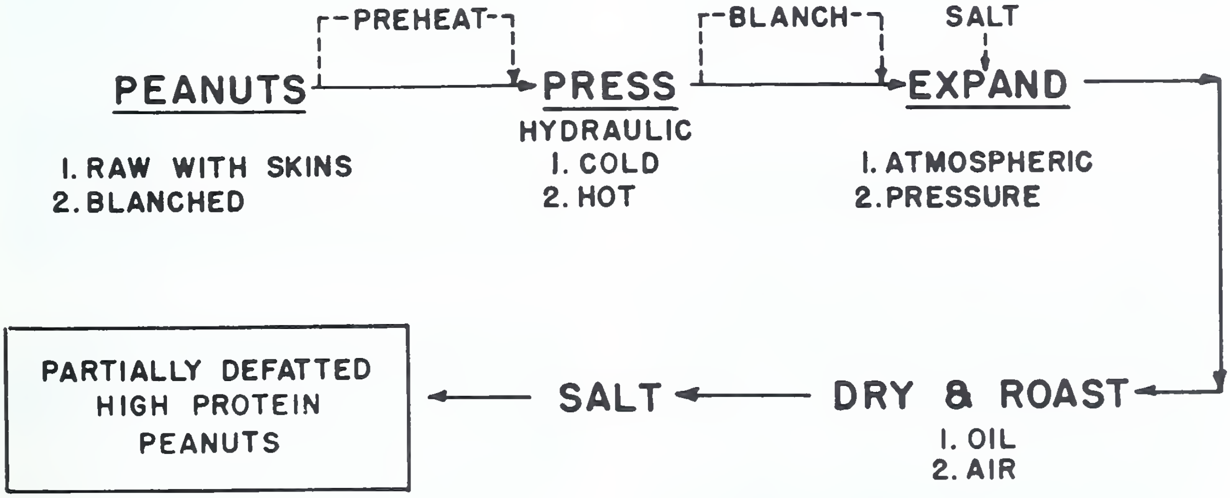

Figure 1.--Flow diagram of the process.

Either blanched or unblanched peanuts are hydraulically pressed to remove up to about 80 percent of the oil. The pressed distorted peanuts are expanded or "reconstituted" to their original shape and a slightly enlarged size by immersing them in hot water, either atmospherically or under pressure. Salting of the peanuts, as well as addition of other ingredients can be accomplished during this expansion stage. The expanded peanuts contain up to about 50-percent moisture. These can be dried and roasted in one step using hot oil or hot air. When roasting in hot oil only a small amount of oil is reabsorbed because the moisture in the peanuts is immediately converted to steam, and while the steam is going out of the peanuts, the oil cannot go in. Salt and other flavoring ingredients can be added after the roasting step if so desired.

The "low-fat" peanut product can be produced with many different variations. For example, the calorie content can be varied by the amount of oil removed; different flavors can be added during the "expansion stage" or after roasting, and the peanuts can be dry-roasted or oil-roasted. Pressed peanuts before expansion can be ground to flours having different tastes (based on treatment of peanuts before grinding, including the amount of oil removed and degree of roasting). A beverage type product was prepared using peanut flour with popped rice flour. In addition to adding flavors during the "expansion stage," vitamins and essential amino acids that are lacking in peanuts may be introduced to produce more nutritious products. This may provide a source of palatable protein for incorporation into the children's feed program for developing countries.

There is a good possibility for the exporting of pressed peanuts to developed countries for further processing into low fat products. It is the pressing operation that requires the most expensive equipment and controlled operational technique. Canadian processors, for example, have already shown interest in this area. Export possibilities for pressed peanuts need to be explored more fully.

Peanut Product Research Contract. -- The purpose of a current contract with a University in Alabama was "to develop peanut products for use in preparation and fortification of foods to extend the usefulness of peanuts."

Flours, meals, and grits are prepared from raw peanuts. Partly roasted peanuts, and full-fat peanuts, each of which is defatted to various oil levels by two methods: (1) Direct solvent extraction and (2) screw pressing. Resulting products are tested for use in snack items and in numerous prepared foods, which, in turn, will be tested for flavor, color, odor, texture, and shelf-life. The following is a brief summary of results obtained to date.

(1) Some degree of roasting is necessary because raw peanut flavor tends to persist through to the final product. This raw peanut flavor can be masked to some extent by the use of flavorings such as butterscotch and maple. Incorporation of prepared peanut materials in baked products showed that those obtained from peanuts roasted at about 310° F. rated consistently higher in flavor.

(2) Fine-textured peanut flour prepared from screw-pressed meals can be used in several products such as soups, spreads, puddings, dips, frostings, ice cream, confections, and bread. The ice cream had an especially good peanut flavor.

(3) Meals with the higher oil levels can be used in some baked products, for example, in cookies and heavier cakes, whereas, peanut meals and grits with lower oil contents were unacceptable for incorporation into many products because of their retention of a gritty texture, even after being subjected to heat and moisture treatments.

(4) In preparing muffins, peanut flours with the three lower levels of oil content (6, 12, and 18 percent) were substituted satisfactorily for up to about 45 percent of the wheat flour. This would more than double the protein content of the muffins.

(5) A peanut flake product was developed which appears to have good possibilities as a high-protein breakfast food. Also, extruded peanut products in the shape of chips, ribbons, and curls have been prepared and show possibilities as snack items.

(6) Full-fat peanut flours, as well as flours containing up to 65 percent oil (up to about 15 percent more than normally con-

tained in the peanut), were prepared by a new double drum drying procedure which was devised during the course of the research. Peanuts are ground to a paste to which water is added and the mixture thoroughly agitated before drum drying.

(7) A series of new products by using mixtures of peanut puree' and fruit puree' may be prepared in the form of instant dehydrated flakes by drum drying.

(8) Shelf-life tests, now underway on many of the above products show encouraging results. For example, prepared products, such as nut-bread mix, applesauce-peanut cake mix, oatmeal-raisin-peanut cookie mix, and peanut ship cookies, can be stored successfully for at least 3 months at 40° F. Peanut flours, including a peanut-applesauce flour, and meals produced by drum drying stored satisfactorily for 2 to 4 months at room temperature. Tests are still underway.

As you can see from this presentation, there are many possibilities for developing of new peanut products for both domestic and foreign consumption. And this, in turn, should help increase the production, export, and consumption of United States peanuts.

If, for economic or other reasons, we cannot export peanut products, perhaps we may be able to export the know-how to major peanut producing countries which also happen to be developing countries. This may be a way of helping them use their own product to upgrade their diets.

RICE FORTIFICATION[1/]

by

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Fortification of rice, or enrichment, as it later became known, began in the United States in 1950 with the establishment of two plants for the manufacture of a vitamin concentrate or premix as it was called by Hoffman La Roche, Inc. One plant was located in California and the other in Crowley, La. Both plants used a process patented by Hoffman La Roche and licensed to two independent corporations, who are still in business today. This venture was partly the cause of a need for the replacement of vitamins in processed rice as shown in Bataan and other processed foods as shown in Newfoundland, and partly the fact that people in the rice industry were afraid that parboiled (or converted) rice, where natural vitamins and minerals are retained, would completely replace white rice on the market.

In 1951, Puerto Rico passed a law requiring all rice to be enriched. This put enrichment on its feet and has helped to build it into the industry it is today.

In 1956, the State of South Carolina passed an enrichment law for rice. Also in this year, Wright Laboratory in Crowley was established using a patented process licensed by Merck & Co., Inc., to manufacture vitamin concentrate or premix. This process produces a product that appears and performs the same as that of Hoffman La Roche, but different materials are used in each process. Since that time Wright Laboratory, Inc., has marketed enough fortification material to enrich approximately 1.5 billion pounds of rice.

In 1957-58, the Food and Drug Administration promulgated a standard for enriched rice, setting the amounts of vitamins and minerals that must be present for rice to be labeled "enriched."

In 1962, a law was passed in the United States that all rice furnished to welfare and institutions by the government be enriched. This added greatly to the volume of rice enriched in the United States.

Initially, the aim of fortification was to replace essential vitamin and mineral loss in processing; in the case of rice, it is

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[1/] Most of the material presented was from a publication by "The National Vitamin Foundation, Inc." entitled "Cereal Grain Enrichment, Why and How."

milling. Because rice loses mostly B_1, niacin, and iron, these are the three substances that are mostly involved in enrichment. Riboflavin is optional because of dark yellow color.

There are two methods used for enrichment today. In the oldest method, an excess of B_1, niacin, and iron are applied to a small amount of rice and coated with a water resistant material. This product is called grain-type premix and is blended at one-half percent with milled rice. The resulting enriched rice may be rinsed in cool water before cooking without appreciable loss of B_1, niacin, or iron.

The other method involves blending the B_1, niacin, and iron together in powder form and applying this powder premix to the rice at rates ranging from 1:1600 to 1:6000. This powder can be rinsed off easily and packages must be labeled, "To Retain Vitamins Do Not Rinse Before, or Drain After, Cooking."

As can be seen, there is quite a conflict between these two methods, but since we have to remain in business, we market both kinds of premixes.

At present, the standards for enrichment are written for the powder type only. There should be a set of standards for the grain type as well, because there is a regulation that requires rice to be labeled, "Rinse to remove glucose and talc," if these two materials are added. If, for instance, a concern in the United States wishes to place glucose and talc on their rice to make it shine and sell better in certain markets, it cannot label the rice "enriched," because of the conflicting regulations that state, "Rinse to remove glucose and talc" and "to retain vitamins, do not rinse before, or drain after, cooking." The concern could add grain-type premix and retain vitamins after rinsing, if a standard existed for this material.

A case actually occurred where rice was marketed unenriched because of this situation, even though the consumer wanted it enriched.

Other rice on the market with vitamins and iron are brown rice (undermilled rice), parboiled rice, and precooked rice. In each of these cases the flavor is changed from regular white rice. For this reason, the man who wants the flavor of regular white rice and added B_1, niacin and iron, enriched white rice is the only product. Enriching rice does not change its flavor. Enriched rice is not available everywhere in the United States. Enriched rice is available only where a grocer demands that the regular rice be enriched and where enrichment laws for rice exist in South Carolina and Puerto Rico.

The cost of enrichment is very small. One hundred pounds of rice can be enriched for about 10¢ by using rinse-resistant grain-type premix, and about 4¢ by using powder premix.

It might be argued, that in countries where the consumption of protective foods is relatively high, such as the United States, and acute severe vitamin deficiencies are not prevalent, what benefit can be derived from enrichment? This can best be indicated from a quotation taken from the Journal of the American Medical Association, June 20, 1945: "The benefits which accrue to the vastly greater number of individuals suffering from milder chronic degrees of these deficiency states, in many cases unrecognized or attributed to other causes, can probably be considered the greatest contribution of enrichment. An improvement in the general health and well-being and an increased efficiency in the population as a whole may be anticipated, since carefully controlled experimental groups have shown measurable benefits as a result of dietary increases of enrichment materials to the enrichment levels..."

PROCESSED RICE PRODUCTS

by
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My remarks today will be confined to the processing of the rice kernel for utilization as food items made from rice as distinguished from the more general term "processing," which embraces the agricultural engineering aspects, such as drying, milling, and storage, as well as those operations aimed at producing products for industrial purposes and byproduct utilization, such as rice bran oil extraction, wax extraction, and rice hull utilization. Brief comments will also be made regarding the export markets and potentials for the major rice food products where such information is available or there is reasonable justification for speculation.

Approximately 12 to 15 percent of the national rice crop is processed into prepared food products of many types. These include parboiled, quick-cooking, enriched, canned rice, canned soups, canned specialty dishes, including rice as an ingredient, with vegetables and animal products, dry soup mixes, breakfast cereals, baby foods, and frozen dishes. Broken grades of rice, because of economic considerations, have also been processed by fine grinding into rice flour, which is used as a thickening agent in products because of its smooth texture and bland flavor. Rice flour finds a unique use as a dusting powder such as in the packaging of refrigerated biscuits, rolls, and bakery products.

Unfortunately, rice does not contain gluten, which is contained in wheat flour proteins. Consequently rice does not lend itself for use in breadmaking, except in very limited quantity. Broken rice kernels, one-quarter of the full kernel size, known in the trade as "brewer's rice," are employed in brewing as a rich source of carbohydrates (starch) for incorporation in the brewing formulation. Some makers of premium beers, as a rule, use rice in their preparation.

Parboiled Rice. --The practice of parboiling rice has been in existence for many centuries in India, Pakistan, and Burma. Approximately 20 percent of the world's rice crop is parboiled. Primarily, the ancient process of parboiling of rice essentially consists of soaking dry rough or paddy rice (in the hull) in an excess of water to bring its moisture content to approximately 30 to 35 percent. The reconstituted rice is boiled in order to gelatinize the starch, the water drained or decanted off, and the "parboiled" rice spread out in the sun to dry. Several factors contribute to the practice of parboiling rice in the far eastern countries.

Gelatinization of the kernel effected during the cooking of parboiling and subsequent restoration of the rice kernel to its normal state by drying cements the interior fissures or fractures, unifies the kernel, and leads to the disappearance of the interior white zones and natural deformities of the kernel. As a result of these structural transformations, the kernels assume a better consistency, greater hardness, and also a better vitreousness. An augmentation in nutritive value also takes place due to the enrichment in soluble vitamins, which diffuse from the exterior to the interior of the grain during soaking and heating. The presence of vitamin E is noteworthy.

As a result of the processing a greater resistance to mechanical breakage during milling is attained, especially during the removal of bran. The "brokens" are reduced to a low value, and sometimes nearly eliminated. Parboiled rice can be stored for long periods without alteration, thus offering an advantage over that of ordinary rice. This is due particularly to several factors, which are:

(1) Sterility because of the elevated temperature of cooking, which destroys the insects, their eggs, and larvae in the grain.

(2) Control of the moisture content, because parboiled rice is less susceptible to relative humidity changes in the atmosphere.

(3) The greater hardness of the kernel obtained by parboiling offers a remarkable resistance to the penetration of insects into the kernel.

(4) A more uniform cooking quality, exhibiting less loss of solids to the cooking water and less cohesiveness of gelatinous character of the cooked kernels.

Because of these advantages, parboiled rice has found its way to Western countries and is a common commodity of diet among U. S. rice eaters. Parboiling of rice on an industrial scale, as practiced in the United States, Italy, France, and other Western countries, is a highly developed food processing operation and much more sophisticated than the rural or village methods of preparation. Several well-recognized patented methods of parboiling, are the Avorio Process in Italy, the Malek Process, the "Converted" Process in the United States, the Fernandes Process in Surinam, and the Cristallo Process in Italy (2). In brief, the "Converted" Process (2) consists of the following steps:

(1) Rough rice is subjected to a high vacum to pull air from the hulls and from deep in the microsopic pores of the rice kernels.

(2) Without releasing the vacum, hot water is run into the tank, then maintained at high pressure to dissolve water-soluble B vitamins and other whole grain constituents from the bran, hull, and germ, and force them into the grain itself.

(3) Then the tank is drained and the rough rice is subjected to live steam. Vacum is applied again, which partly dries the wet rice.

(4) Further drying is accomplished by use of conventional drying apparatus. After 8 hours in tempering bins, all rice reaches the same dryness of approximately 12 to 13 percent moisture content. Parboiled rice is milled in the conventional manner. The polished milled rice is a rich cream color but cooks to the snowy whiteness of the untreated rice.

Our Western Utilization Research and Development Division (WURDD) in Albany, Calif., has extensively investigated the process of parboiling rice and published their findings.

Almost 27.1 million cwt. of U. S. rice was inspected for export from the South during the 1965-66 marketing season. Twelve percent was parboiled and 5 percent parboiled brown rice. Most of the parboiled brown rice was the Bluebonnet (long-grain) variety and was shipped to the Republic of South Africa; nearly two-thirds of the parboiled rice inspected for export was the Belle Patna (long-grain) variety.

Quick-Cooking Rice.--In keeping with the modern trend of living and present consumer preference, convenience food items have been universally accepted by the American public. Quick-cooking rice is one such food product. In contrast to parboiled rice, which is more dense and requires a longer cooking time than raw milled rice, quick-cooking rices are light, porous, take up water readily, and can be prepared for the table roughly in 5 to 6 minutes. There are many approaches to the method of rendering raw milled rice into a quick-cooking product. Essentially the process consists of reconstituting premium grade and selected rice varieties in water to attain a moisture content of approximately 35 percent. The rice is then cooked, sometimes under pressure, and subsequently dried under controlled conditions of temperature in an airstream (3). Frequently, before reconstituting rice in water, a hot-air blast is employed to effect fissuring of the rice kernel to promote porosity as an aid in speed of water reconstitution. Other methods employ pressure cooking followed by release into a vacuum to effect increased porous structure of the kernel (4). More recently, approaches to effecting quick-cooking properties employ soaking and cooking of the rice, then freezing, thawing, and dehydrating, or drying (6). The final dehydrated product can be prepared for consumption in approximately 5 minutes or less with the addition of the recommended quantity of hot boiling water. Several other processes, employing the puffing-gun and pressure-vacuum methods are responsible for quick-cooking products (5). The Southern Utilization Research and Development Division in New Orleans has been active in the field of freeze-processing prepared rice products (7, 8).

Data on actual production of quick-cooking rices are not readily available. Quick-cooking rices should have excellent potential for export to countries that can afford and that like convenience-type products. It should prove advantageous in those developing countries where fuel is costly or scarce or both.

Canned Rice.--Under another form, canned rice may be considered a type of quick-cooking or convenience product. Parboiled rice was formerly used as the raw material for preparing of canned rice because of the stability of the kernel and retention of its shape without disintegration under rigid retorting and heating conditions. Research at WURDD revealed that limiting the moisture content of the canned product to approximately 55 percent overcame many of the difficulties of employing raw milled rice as the raw material (10, 11). In brief, the canning process consists of:

(1) Soaking the rice to its equilibrium moisture content of about 30 to 35 percent.

(2) Cooking it 4 to 5 minutes in excess water.

(3) Draining and packing the rice into cans.

(4) Vacuum sealing and retorting.

An inherent disadvantage of canned rice is the "clumping" of the kernels so as to prevent ease of emptying the contents of the can. This difficulty has been overcome by research at WURDD by use of surface active agents, which reduce the surface tension between cooked kernels, thereby permitting the contents to exist as discrete, individually separated more or less free-flowing kernels (12).

Similar use of buffalo fat by Indian researchers for the same purpose has helped promote the use of canned rice and avoid these difficulties in its use in India (14). A recent patent by a Canadian firm employs the use of freeze-processing, previously described for preparing quick-cooking rice, to alleviate the "clumping" of canned rice (9). In this case the processed rice is frozen in the can, then thawed before labeling, and released for use.

Canned rice has the same potential in the same markets as quick-cooking rices. Possibly, the export potential may be better inasmuch as canned foods are well-known and almost universally accepted. Canned rice has an advantage in that it affords an opportunity to introduce diversification in the recipe formulation of dishes containing rice. A major disadvantage for export, however, may be the cost of shipping.

Breakfast Foods. --Ready-to-eat cereals, in general, are precooked, dried, flaked, and/or expanded, and toasted as breakfast foods. The differences of preparation are the cooking time, steam pressure, temperature, and the addition of malt and nutrients. Rice flakes and puffed rice are prepared from quality raw milled rice, usually of the short-grain type. Cooking rice for making flakes requires about 18 to 19 pounds steam pressure. The duration of cooking is about 20 minutes, bleeding for 5 to 10 seconds, and additionally cooking for 1 1/2 hours. Ingredients are polished rice, malt syrup, ground wheat bran, white sugar, corn sugar, salt, and vitamins for enrichment. In the case of puffed rice, frequently the rice is parboiled, and sugar syrup with salt is added and the mixture cooked for approximately 5 hours under 15 pounds steam pressure. Nondiastatic malt syrup and enriching ingredients are added before cooking. The lumps of cooked rice are broken up, dried to 25 to 30 percent moisture content, and tempered. The grain mass is given an additional heating with radiant heaters to plasticize the kernel surfaces. The rice kernels are then passed through flaking rolls and subsequently put through toasting ovens to secure the puffed effect. A cereal called "Special K," manufactured by the Kellogg Co., is basically a cooked rice kernel, which is coated while moist with wheat gluten, wheat germ meal, dried skim milk, debittered brewer's yeast, and other nutritional adjuncts. Finally, the material is oven-puffed. Gun-puffing may be used instead of oven-puffing to attain expansion of the product (13).

The introduction of breakfast cereal factories into foreign countries has proceeded rather rapidly in the last two decades. These foods have had immediate acceptance in all areas where a good product has been offered. The future of the foreign market seems very promising. Introduction of American cereal breakfast foods into foreign countries is an excellent example of how eating habits of foreigners have been changed by a concerted effort.

Rice Baby Foods. --Generally, rice baby foods are prepared by cooking ground broken rice kernels or polish or both, adding nutrients, and drum-drying the rice slurry. The dried rice is then broken up into flakes and the mixture canned.

The most extensive use of rice baby foods other than by infants is undoubtedly by older people and those requiring special diets. The use of a fortified convenient food of this type is extremely appealing. No elaborate facilities are needed to prepare them and they are economical to use.

Rice Flour. --The presently available rice flour of commerce in the United States is of two types. The first is produced from the waxy or glutinous rice, which is commercially grown in rather limited quantity in California. This waxy rice flour has superior qualities for use as a thickening agent, such as for white sauces, gravies, and puddings, in preventing liquid separation (syneresis) when these products are frozen, stored, and subsequently thawed. A characteristic of waxy rice starch is that it has little or no amylose--one of the two principal constituents of cereal starches. Since the waxy rice starch is essentially amylopectin, the other principal constituent of cereal starches, flour prepared from it has this unique food-use property. The other type of commecial rice flour is prepared from the broken grains of ordinary raw or parboiled rice. When prepared from parboiled rice, the resulting flour is essentially a precooked flour. Because rice does not contain gluten, as previously noted, the use of rice flour is rather limited for confectionery purposes. Instead, it is employed usually as a thickening agent in gravies, sauces, and as mentioned earlier, as a dusting powder in preparing and packaging refrigerated bakery products (15, 16).

The most recent rice research at the Southern and Western Utilization Research and Development Divisions has been directed towards the development of techniques related to the production of a high-protein rice flour. Earlier work at Mysore, India, and more recent investigations under a Public Law 480 contract at the University of Valencia, Spain have demonstrated an unusual degree of heterogenous dispersion and high concentration of protein in the outer layers of conventionally milled rice kernels. These findings have far-reaching significance in the study of rice compositional, histological, and utilization problems. A potential utilization aspect is the practical availability of rice flour of higher protein content than has previously been obtained by conventional methods.

SURDD at New Orleans has been concerned almost exclusively with the investigation of the distribution of protein and other nutritive constituents in both long and medium-grain rices grown in the Gulf Coast area (17). Some results of these laboratory studies have been previously published. A new specially designed laboratory mill was employed in these studies that removed the outermost layers of the rice kernel as a finely divided flour with a minimum of breakage and insignificant development of frictional heat. This mill was also used to investigate the protein distribution in the surface layers of selected American varieties of wheat, barley, grain sorghum, and glutinous rice. The findings were published (18). A practical accomplishment resulting from these studies was provision of a means for making available rice flour fractions containing from 15 to 20 percent protein. This represents separation of a higher protein content material in greater quantity than was previously obtainable by air-classification of conventional rice flour prepared by grinding the whole milled kernels. Availability of rice flour of higher levels of protein suggests that this material should be investigated in balancing the diets of peoples in some developing countries, for incorporation in and upgrading baby, geriatric, and nonallergenic dietary products, for the development of entirely new food products, and for use in specialty food products, such as salad dressings, rice milk preparations, and meat extenders. Consequently, continued research was aimed at translating the laboratory method of flour production to a commercial scale and determining the chemical and physical properties of the prepared flours.

The first approach toward commercial scale rice flour production required an experimental rice milling machine for processing greater than bench-size samples of flour. Such a device was designed and fabricated by the Machinery Development Investigations, Cotton Mechanical Laboratory (19). Using this mill, the Laboratory removed from the outer surfaces of the rice kernels 12 successive flour fractions, which required a total of 2 hours of operation. Each fraction was removed in 10 minutes of continuous operation and each averaged approximately 1. 5 percent by weight of the kernel.

The initial rice, flour fractions, and residual kernels were analyzed for moisture, protein, lipids, starch, amylose, thiamine, riboflavin, niacin, phosphorus, calcium, and amino acids content of the protein.

Ultimately, the availability of high-protein rice flour is contingent upon the technical and economical feasibility of its production on a commercial scale. Consequently, because of the successful production of rice flour of high protein, vitamin, and mineral content on a pilot-plant scale, experiments were conducted to determine whether a commercial model of the Satake Rice Whitener, of Japanese manufacture, could be used to tangentially abrade high-protein rice flour from conventionally milled rice. The machine, as installed by personnel of Riviana Foods, Inc., Houston, Texas, allowed the milling of 2,000 to 2,500 pounds of long-grain rice to a depth of 8 percent weight removal in 1 hour. Fifteen percent by weight of another lot of rice was abrasively milled in five successive fractions representing 3 percent weight removal increments.

Chemical analysis and physical property determinations were conducted on the five fractions of flour. Protein decreased from 15.1 to 14.5 percent; fat from 12.8 to 1.7 percent; and starch increased from 42.9 to 79.1 percent in successive fractions. Compared with the original whole rice, viscometric properties of the five flour fractions exhibited unusual properties. Residual kernels exhibited progressively higher values of pasting characteristics than did the initial rice.

It was additionally shown that flour abraded from "brokens" averaged approximately 14 percent protein in a weight fraction of roughly 7 percent. The removal of approximately 5 percent of the peripheral layers of milled parboiled rice yielded a flour of approximately 20 percent protein.

Organoleptic evaluation of the cooking quality of the residual kernels remaining after different degrees of deep-milling of long-grain rice indicated a peak in cooking quality exceeding that of the original rice at approximately 5 to 8 percent flour removal.

The investigations to date at SURDD provide experimental evidence that commercial milling equipment, such as the Satake Rice Whitener and similar abrasion-type machines, may be adapted to the manufacture of high-protein rice flour. Results also indicate that high-protein rice flour of good quality may be milled from "brokens". While it is not envisioned that the development of a high-protein rice flour in the United States will be helpful in supplying protein to developing countries, the development of the product could be a useful adjunct to the domestic rice milling and processing industries in that it would provide a whiter rice of improved cooking characteristics and a high-protein flour which may contribute to the value of many domestic dietary products.

Additionally, the availability of a high starch, low protein, and low fat residual kernel should prove of interest to the brewing industry, which uses the major quantity of brokens' grades of rice in the United States.

In comparison with other cereal flours and farinas, the use of rice flour is rather limited, except for specialized purposes as mentioned earlier.

The world produces as much rice as wheat, if not more, but in contrast to wheat more than 90 percent of the rice is produced and consumed in Southeast Asia and in the Far East. United States produces about 2 percent of the world's production of rice, which is about half that produced by our good neighbor to the south--Brazil.

United States, however, exports approximately 50 percent of its rice production and is the second largest exporter of rice in the world. Each year United States ships rice to 35 to 40 different foreign countries, including the Far East--the rice bowl of the world! In view of this, it is reasonable to speculate that United States can increase its foreign trade by developing of rice products that foreign consumers want. For example, the European consumer is also demanding more convenience-type foods. Quick-cooking rices are moving up in sales. In some countries 35 to 40 percent of the women work outside the home. The working young housewife of today desires a food that is quick and easy to prepare, yet one that is nutritious and tasty. She is willing to pay for this convenience as demonstrated by new customers for precooked and other convenience-type specialties. New rice products are finding reasonable acceptance in more and more European homes.

An anomalous situation is that a relatively small quantity of broken rice is imported into the United States each year for use in beermaking. Demand for brewers' rice requires this and, consequently, depletes the supply of this raw material for use or incorporation into various food products, such as baby foods and flour.

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DEHYDRATED AND PROCESSED TROPICAL FRUITS AND VEGETABLE PRODUCTS

by

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(Presented by R. E. Berry)

Many fruits and vegetables are produced in the Tropics that lend themselves well for processing into a fairly large variety of products. This discussion will be confined to those products with which we have worked, with those which are already being produced in Puerto Rico, or with those which are at a stage of development that assures they will be processed in the near future.

To bring into proper perspective the production potentials of products manufactured in Puerto Rico, some background information on the island's agricultural production and food processing industry is necessary. The island of Puerto Rico is approximately 113 miles long by 41 miles wide. Around the coast is a narrow fertile plain that rises gradually toward the interior, in a series of mountain ranges that occupy the major part of the island surface. Of the total area of 2,250 million acres, only 745,000 acres are under total or partial cultivation; 800,000 acres are in pasture, and 300,000 acres in forests, woodland, and marshes. Around 500,000 acres of agricultural land have a slope of 60 percent or more.

The principal crops are sugarcane, coffee, and tobacco. Pineapples, tomatoes, guavas, oranges, pigeon peas, root crops, and miscellaneous fruits and vegetables are produced for the fresh market and for processing.

The Puerto Rican food processing industry comprises at present about 475 establishments (2) processing a large variety of products such as tuna fish, fruits and vegetables, spaghetti and macaroni, bakery products, soluble coffee, drinks, and beverages.

The canning of fruit and vegetables is one of the most important food-processing operations with sales amounting to $20 million a year. The principal crops processed are pineapples, tomatoes, oranges, guavas, and plantains. Other fruits and vegetables are processed on a much smaller scale, either for the local market or for export to the mainland United States.

It is obvious that with the limited land available for crop production, Puerto Rico cannot develop a processing industry based on the production of items which can be produced elsewhere on much larger scale and, consequently, at a lower price. Tropical fruits and vegetables, because of their very special nature, lend themselves very well for the production of specialty items which usually command a high price in both the local and the export market.

Now let us take a look at what we can do with the various tropical fruits and vegetables that can be produced in Puerto Rico. Since pineapple and tomato products are well known, we will not include these products in our discussion.

The guava is one of the most versatile of all tropical fruits. It is used to make jellies, jams, fruit bars, nectars, drinks, and syrups. It is normally processed into a juice extracted by boiling (18) to make the jellies, and into pulp (16) which is either hotpacked or frozen to be used later to remanufacture some of the other products. From the pulp, nectars (12) and drinks are prepared by diluting with water to suitable consistency, adding sugar, citric acid, if necessary, to adjust the pH, and artificial color. The guava pulp contains stone cells that impart an undesirable grittiness to the drinks. The stone cells can be removed by centrifugation (20) from the diluted pulp dispersion or broken down in the undiluted pulp by means of a stone mill. The flavor and vitamin C content of the nectars and drinks are related to varietal characteristics. Nectars prepared from fruit high in vitamin C may contain well over 30 mg. of ascorbic acid per 100 ml.

The pulp is generally used also to prepare a fruit bar (10) which is very popular in Puerto Rico. The fruit bar is prepared by cooking the pulp in open kettles with about an equal weight of sugar to 67° to 70° Brix. The mixture is poured into waxed or cellophane-lined cardboard containers and let to cool. A firm product, which cuts clean with a knife, is obtained. This fruit bar is generally served as dessert with unprocessed white cheese.

The pulp can also be cooked to jam consistency which can be used as such, as a pie filling, or for confectioneries. The pulp can also be used to make guava flavored ice cream.

By using the pulp as starting material (4), through the use of clarification and centrifugation, three types of table syrups can be prepared. These syrups differ among themselves by the pulp in suspension, ranging from a transparent pulp free syrup to an opaque pulpy one. These syrups can be used to make drinks, sherbets, or served with pancakes.

Next in versatility is the papaya. The ripe fruit is used to make nectars and drinks. The green fruit is sliced and cooked in medium syrup which can be packed in tin or glass containers. This product can be used directly as a dessert. One of the local bakeries is using this product to make pies. The green fruit can also be candied to be used for making fruit cakes.

Mangos are generally processed into nectars (19), fruit bars, and sliced to be packed in syrup. Mango nectar has a color and flavor somewhat reminiscent of peaches. The fruit bar is used like the guava, as a dessert. Only nonfibrous varieties are adequate for canning as slices.

Soursop is perhaps one of the less known tropical fruits. The fruit is the largest of the annonaceous fruit. It is heart-shaped, deep green in color, with numerous short fleshy spines on the surface. The flesh is white, juicy, and highly aromatic, and produces refreshing drinks of pleasing flavor and aroma. It is used only to make nectars (15) and drinks, and used as flavoring for ice creams.

The Cinderella of the tropical fruits is the Acerola or West Indian cherry. It remained a backyard fruit until a few years ago, when Asenjo and coworkers (1), (6) of the University of Puerto Rico discovered its high vitamin C content. This fruit looking somewhat like a cherry contains as much as 4,000 mg. of ascorbic acid per 100 g. of edible pulp. The juice changes in flavor and color when hotpacked (11), but retains its high vitamin C content. It can be dehydrated into a powder, which is produced commercially in Puerto Rico. This powder is used as a source of natural vitamin C to enrich various foods and in pharmaceutical preparations.

Coconuts are generally used in the shredded drhydrated form in the manufacture of confectioneries. We cannot hope to compete in the shredded coconut market with other areas producing coconuts in large quantities and with much cheaper labor. Looking for some special coconut products, Cancel[1/] from our Laboratory developed three coconut products, which we hope can be marketed without much difficulty.

A coconut milk concentrate is prepared by shelling the coconut with steam to separate the meat from the shell. The meat is comminuted and the milk extracted by pressing in a hydraulic press. The milk is centrifuged and concentrated under vacuum to a fourfold concentration, 22-percent solid content. The concentrate is flash heated to 260° F., rapidly cooled, packed in tin cans, and stored at -10° F. This product, which keeps without any change in flavor for a year, can be used in confectioneries and ice cream manufacture. Its main advantage is that it has the characteristic flavor of fresh coconut products and lacks the undesirable rancid flavor generally associated with products prepared from dehydrated coconut shreds.

A fat-free flavor concentrate can be prepared by separating the milk into an aqueous and a fat phase by proper adjustment of pH and centrifugation. The fat-free water phase is suitable for the preparation of soft drinks

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[1/] Cancel, L. E. Personal communication. Puerto Rico Univ. Agr. Expt. Sta., Food Technical Laboratory. 1967.

and refreshments. The fat phase containing about 75 percent fat can be used as a flavoring ingredient in the preparation of ice creams and confectioneries.

Plantains (Musa paradisiaca) are widely used throughout the tropics as food. The green fruit is generally used as a vegetable. The economic potentials of this fruit as raw material for processed products has been neglected in most tropical countries. Our work shows that plantains can be advantageously used to prepare several types of snacks and some convenience products. Cancel and coworkers (3) developed procedures for the preparation of plantain chips. In preparing this product, green plantains are sliced and deep fat-fried. The product has a golden yellow color, is crisp, and has a pleasing flavor that goes very well with drinks. It is usually sold in flexible containers like the potato chips. Gonzalez[2] developed another fried snack from plantains, which somewhat resembles shoestring potatoes in appearance. The green plantains are masked and heated to partly gelatinize the starch. The resulting dough is extruded and deep fat-fried. The product can either be packed in plastic bags or canned under nitrogen or vacuum.

Green plantains can also be kept frozen for over a year without any change in organoleptic quality. The plantains are peeled, sliced crosswise, steam-blanched, and cooled. To avoid surface browning and discoloration a sulfite dip can be used. The slices are packed in plastic bags or in frozen food cardboard containers, rapidly frozen at -45° F. and stored at -10° F. The frozen plantains can either be served boiled or fried.

Ripe plantains are widely used in Puerto Rico to prepare several types of dishes. One of the most popular is prepared by cooking the ripe plantains in heavy syrup. We have developed procedures for the (14) preparation, packing, and freezing of this product. The ripe plantains are harvested when the starch content is less than 4 percent, peeled, and sliced crosswise into three segments. The plantains are boiled in sugar syrup with cinnamon and lime peel. The plantains are packed in boilable pouches with syrup and quickly frozen at -45° F. and stored at -10° F. For serving it is only necessary to boil the bags for 15 minutes.

Pigeon peas (Cajanus cajan) are the peas of the tropic. Pigeon peas are highly nutritive with a protein content of 7 percent when green, and with a caloric value of 118 cal. per 100 g. (21). They also contain ascorbic acid, thiamine, riboflavin, niacin, and vitamin A. Pigeon peas are canned green. The process for canning pigeon peas (17) is similar to that used for peas. The pods are shelled; the peas are sorted and inspected to remove defects, water-blanched, washed, and packed in cans with 2-percent brine. The product can be stewed like beans or used as green peas in salads.

Pigeon peas can also be frozen (13). Processing is similar to that used for canning, except for the freezing stage, for which quick freezing is to be preferred. Frozen pigeon peas last for more than a year when stored at -10° F. without changes in flavor or color, provided the blanching treatment inactivates the oxidizing enzymes. If the enzymes are not inactivated, off-flavor development results.

Pigeon peas can also be dehydrated. Rahman (8) showed that pigeon peas soaked in sodium hydroxide before dehydration had a higher rehydration ratio than the untreated ones, regardless of their stage of maturity. Dehydro-frozen pigeon peas were also studied by Rahman (9). However, possibly due to marked consumer preference for the fresh and canned pigeon peas, no dehydrated peas are produced commercially at present.

We have explored the possibility of dehydrating some of the tropical fruits and vegetables. Rahman (7) studied the dehydration of green plantains and obtained a flour with about 70 percent starch and 3.0 percent protein. This flour can be used to make plantain-flavored cakes and plantain purees, and also used as a baby food. However, because of high cost, the flour has not been produced on commercial scale with any success. Although other root crops like tanniers and yams can be dehydrated to produce a flour, the high cost of the final product also limits its commercial production. We are exploring the possibility of using these flours to prepare snacks or instant mixes to be used by the homemaker to prepare several recipes. Most of these root crops like yams and tanniers are similar to sweetpotatoes but each has its own characteristic flavor. There is the possibility that products similar to the instant mashed sweetpotato can be prepared.

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[2] Gonzales, M. A. Personal communication. Puerto Rico Univ. Agr. Expt. Sta. Food Technology Laboratory. 1967.

We have explored the possibility of freeze drying some products used as condiments. Gonzalez[3] from our Laboratory is studying the freeze drying of a sweet pepper (Capsicum frutescens). These peppers, which are small in size--around 1-inch in diameter--can be freeze-dried either whole or cut in halves in an 8-hour cycle to 3-percent moisture. The dehydrated peppers reconstitute rapidly in cold water and is similar in flavor and color to the fresh product. Since these peppers have a very pleasing flavor and are widely used as condiment, and also are high priced, we foresee a good market for the freeze-dried product.

Brined citrons are produced in Puerto Rico for the American and European markets. The brine citrons packed in brine are shipped in barrels. Shipping costs are very high because of the weight and volume of the barrels. Benero[4] successfully dehydrated the cured citrons obtaining a product with 6-percent moisture. When reconstituted, it is similar in flavor and other characteristics to desalted fruit used for candying. Because on dehydration the weight of the brined fruit is reduced to about 95 percent with a considerable reduction in volume, substantial savings in shipping costs will result.

Although we grow bananas in Puerto Rico, due to our limited cropland, we cannot hope to compete with other banana producing countries in the fresh fruit market. However, we could produce dehydrated banana in the form of flakes or powder and frozen or aseptically canned banana puree. The principal banana grown in Puerto Rico is the Cavendish, which is somewhat different to the gross Michel in flavor. Our experiments show that we can produce a high quality dehydrated banana or frozen puree from this variety.

So far we have discussed the processing of some of the tropical fruits and vegetables which are produced in Puerto Rico. We should not overlook the potentials of other processed products in which tropical vegetables and flavoring herbs are used as ingredients. Rodríguez[5] from our Laboratory has developed several condensed type soups using tropical vegetables and root crops combined in Puerto Rican style recipes. TV dinners using Puerto Rican recipes have been developed by Lilia González (5).

We have discussed just a few of the many products that can be prepared from tropical fruits and vegetables. Some of the products mentioned are so new that their market potential is not known. We realize that in marketing these products, particularly in the export market, our main problem is adequate consumer acceptance, which would be difficult to predict in view of the newness of the products with which we are dealing.

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COTTONSEED FLOUR FOR HUMAN CONSUMPTION

by
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Cottonseed, one of the principal oilseeds in the world, is a good potential source of high quality food protein. The annual production of cottonseed is about 25 million tons. This is in comparison with 18 million tons of peanuts and approximately 35 million tons of soybeans. Previous presentations on soybeans and peanuts have highlighted some of the information concerning these commodities and their utilization.

Now about cottonseed. U. S. production is approximately 25 percent of the 25 million tons. This annual production of 25 million tons of cottonseed is equivalent to over 5 million tons of protein and in the form of 60 percent protein flour this would be equivalent to over 8.3 tons.

The world is in urgent need of protein, particularly in developing countries where much hunger and starvation prevails. In some of these countries sources of protein exist in the form of oilseeds such as cottonseed. This situation will become more acute, more grave, in the immediate years as the population begins to expand and explode.

As far back as 1910, hope was expressed for cottonseed meals or flours to be used in human foods, but very little tonnage produced over the years actually found use in food channels. We all know and are all familiar with the problems that arose limiting cottonseed meals principally as a feed for cattle. As the years progressed, research in technology and engineering made many improvements in processing of cottonseed. Through these improvements and the diligent efforts of trade associations such as the National Cottonseed Products Association (NCPA), much advancement has been made to achieve full utilization of the oil and meal products from cottonseed. Over the years cottonseed oil has enjoyed wide utilization in many food items. Today, cottonseed meal is finding increasing uses in practically all feed channels--on the farms, on the range and in the poultryhouses.

Today, many people in this country, in industry, in government groups such as our own Agricultural Research Service (ARS), Agency for International Development (AID), and United Nations Children's Fund (UNICEF), are actively engaged in research, promotional activities, research activities, and programs to aid developing countries in using oilseed flour such as cottonseed flour as food that meets to a great extent their protein requirements. We hope that we can eventually help these people to use their own farm crops, such as cottonseed, to produce food for themselves. Thus, our interest in this country in developing cottonseed protein flours and foods is not so much for our own immediate use but to help developing countries.

The question one must ask is whether, with our present technology and engineering as practiced by the U. S. cottonseed industry, a food grade flour can be produced--one that is acceptable to be mixed or blended with grains and other food materials for preparation of formulated foods.

Quite a few problems must be adequately solved before a high-grade food flour can be produced from cottonseed. These are as follows:

(1) To produce high grade protein flour, only prime, mature, sound oilseed, free of contaminants should be used.

(2) A plant for production of food grade flour should be an integral part of a larger plant designed to produce feed grade meal also. To produce flour of 55 percent protein or higher, and for other quality considerations, it will be necessary to divert part of the meats stream to a second processing line that would produce feed grade materials. In the case of cottonseed, through such provisions, it will be possible to produce 300 to 400 pounds of 60-percent protein food grade cottonseed flour from a ton of seed.

(3) For cottonseed, the main concern over the safety of cottonseed products in human diets is caused by the occurrence of gossypol in glanded cottonseed. Many are of the opinion that the gossypol content, both free and total, should be extremely low so as to maintain maximum quality meal and to rule out any adverse physiological effects upon humans in the prolonged use of cottonseed flours.

(4) To achieve maximum benefit from a nutritional standpoint, it is desirable for processing to yield a final flour which approximates the protein quality present in the original seed.

(5) It is preferable that the flour have less than 1 percent residual lipids to insure quality of the product upon prolonged storage.

(6) It is desirable to have a protein content as close as possible to 60 percent. This results in a low fiber content in the flour--3 percent or less.

(7) The product should be free of mold contaminants that adversely affect its quality.

(8) The flour should have no objectionable odor. In fact, it should possess an acceptable flavor, as judged by U. S. standards, or the standards of the foreign country in which it is being utilized.

(9) The protein flour should be finely ground so that essentially all passes a 200-mesh screen. It should have right texture.

(10) The flour should be light in color very pale yellow.

(11) The flour should be free of solvent.

(12) The flour should be relatively free of deleterious solvent contaminants, decomposition products, etc.

(13) The flour should be prepared under sanitary conditions that meet standards set by food processors and by government.

(14) Oil quality and yield should be maintained.

I have a sample of a commercial cottonseed flour produced by the Traders Oil Mill, Fort Worth, Tex. This cottonseed flour has been used in this country for some time, particularly in bakery products where a small percentage of the product has certain advantages. I believe that it meets all the specifications set out by UNICEF for cottonseed flour. Some of the U. S. cottonseed oil mills are of the opinion that they can make necessary changes in their processing to produce food grade cottonseed flour particularly for use in world food programs. They are currently studying the problem associated with such an endeavor.

Commercial efforts are underway in Central and South America in which cottonseed flour is being used in food formulations. Incaparina formulations, including 38 percent cottonseed, is used in these countries. It is being tested in Central America, particularly Guatemala and Panama. It is being sponsored by the Institute of Nutrition of Central America y Panama (INCAP). In recent years children have been fed this product in carefully controlled tests. Some have continued for more than a year and no detrimental effect was observed. It has been reported that the sales of Incaparina has totaled recently over 4, 500, 000 pounds. This is an increase of 32 percent over the previous year. In Colombia and in Venezuela, Incaparina is being produced and marketed for beverages, soups, and gruels. Peravita--a high protein food product--is being marketed in Peru. Two types of Peruvita are produced--one salted, and one sweet--consisting of 56 and 50 percent cottonseed flour. Thus, in South and Central America, testing of cottonseed flour in food formulations is yielding some interesting results.

We believe that ultimately advancements through research on both processing and product quality of flours from cottonseed can be made. Such research at the Southern Utilization Research and Development Division (SURDD) is yielding some successful results.

Gossypol is a polyphenolic compound with two carbonyl groups and possesses the interesting property of forming compounds with acids and bases. The pigment glands, principally the gossypol pigment present in the gland, are responsible for the oil color problems and, depending upon processing conditions, can appreciably adversely affect the quality of the meal or flour product. Pigment glands are from 60 to 180 microns in diameter, equivalent to 2/1000 to 7/1000 inches. They are elliptical in shape. Cottonseed flakes, conventionally prepared are about 10/1000 inches thick. Thus, you can see that not many of these pigment glands are ruptured during this operation. The thought I want to get across is that in conventional processing, such as prepress-solvent-extraction using commercial hexane, the preparation operations often involved, together with the poor solvent power of the hexane for gossypol, only partly removed the gossypol from the prepared cottonseed meats. Much of the gossypol remains in the final meal in bound form. This is responsible for appreciably lowering the lysine values. Thus, the nutritional value of the meal is adversely affected.

Let us look at cottonseed meal, a 50-percent protein product prepared from glanded cottonseed by prepress-solvent-extraction operation--a commercial operation. It is a typical one. It has a free gossypol content of about 0. 03 and a total gossypol content of about 1 percent. The epsilon amino free

(EAF) lysine value is less than 3. 15 g. for 16 g. of nitrogen. Now let us look at a flour prepared at SURDD from glandless cottonseed by a process very similar to that used for producing meal from soybean flakes. This flour was prepared by solvent extraction with commercial hexane of hulled free flaked meats. We remove essentially all the hulls before extraction to obtain a high protein material. This protein content is above 60 percent. Notice how white this particular flour is in comparison with the flour produced from the glanded cottonseed. There is extreme differences in color. The gossypol, both free and total, in the glandless cottonseed flour is less than 0. 01 percent. The EAF lysine value approximates 4. 0 g. per 16 g. nitrogen. It is a high-grade food product--one that could find many uses in food formulations where high-quality protein is needed. One will readily ask what are the prospects of producing cottonseed flour for food uses from glanded cottonseed that approximates the quality of flour prepared from glandless cottonseed. No doubt, we will be processing glanded cottonseed in this country for some time and perhaps longer in foreign countries.

We have been giving this matter serious attention at SURDD. Our efforts have been directed along several lines of research and all are yielding, I think, promising results. We are looking at processes to produce high-grade food flours from cottonseed by techniques in which: (a) We rupture the pigment glands in the prepared flaked meats through solvent-mechanical action which simultaneously removes the gossypol with the oil in the micella (oil-solvent mixture); (b) through classification, both liquid and air classification, processes are designed to avoid rupturing the pigment gland; and (c) mechanical approaches involve cold pressing of cottonseed meats, together with other materials, through a screwpress followed by extrusion operations.

We have been investigating solvent systems (polar solvents) to rupture the pigment glands and extract or remove gossypol readily. These solvents have been used in our pilot-plants. These solvents involve conventional type extractors, and some departures of equipment such as vibrating screens, centrifuges, and liquid cyclones. These departures are for handling finely comminuted cottonseed meats. In such a form, both the oil and gossypol are extracted completely and rapidly.

Several solvents and solvent combinations have been receiving our attention. These are acetone, acetone-water mixtures, acetone-water-hexane mixtures, ethyl alcohol, isopropyl alcohol, methyl ethyl ketone, and methyl acetates. Some of the most promising systems involve the use of acetone. I have before me two cottonseed flours--one prepared in a process by extraction of cottonseed flakes with a solvent mixture of acetone-hexane-water. The process and the product are results from research of several people at this laboratory, principally led by Dr. Frampton, Oilseed Crops Laboratory, and Mr. Gastrock, Engineering and Development (ED) Laboratory. The other is a product from a two-stage extraction process. In the first stage, aqueous acetone (25 to 30 percent water by weight) is used. In the second stage anhydrous acetone is used. This process is the result of research underway both in the Oilseed and ED laboratories. These two flours are light in color (light yellow) and high in quality and should eventually find acceptance in some food uses. Both flours were prepared from prime glandless cottonseed. For the acetone, hexane water (AHW) flour, the preparation was in a conventional basket extraction pilot plant using a mixture of 39 percent acetone, 60 percent hexane, 1 percent water. The resulting oil micella from such processing contains all the gossypol pigments extracted from the prepared meats. Extensive feeding tests with this AHW meal (or flour) have been made. It has been fed to swine, poultry, and even to infants after weening, and excellent results have been attained. The AHW meal product has proven to be better in quality from the standpoint of nutrition than any commercial cottonseed meal and is comparable in quality to high-grade soybean meal. Such a flour eventually should find potential use for producing quality edible high grade protein flour from cottonseed. In the first stage of the two-stage process, the acetone-water mixture extracts practically all the gossypol, most of the free-fatty acid, some raffinose, very little oil, and effectively removes aflatoxin if present in the meal. The extract from the first stage is about 5 to 7 percent by weight of the prepared cottonseed meats. In the second stage the anhydrous acetone removes the oil and this crude oil is essentially comparable in quality and color to that of a semi-refined oil. For both the AHW process and the two-stage aqueous acetone, anhydrous acetone process it is possible to bring the total gossypol content down below 0.10 percent by incorporating a solvent milling or grinding operation before extraction. Thus, by mechanical-solvent effects the pigment glands are more completely disintegrated and gossypol more completely extracted. By using flakes as low as 7 thousandths of an inch in thickness, the total gossypol in a final meal product can be reduced as low as 0.15 percent. The nitrogen solubility of both of the flour samples from these two processes is about 85 percent and the EAF lysine approaches 4.0 g. per 16 g. of nitrogen. The protein content of the flours, you might notice from the label, is about 60 percent for the flour from the AHW process and 70 percent for the one from the two-stage process.

There is a flavor problem associated with the use of acetone. This is due to minute quantities, p. p. m. of diacetone alcohol or mesityl oxide being present or formed during processing. It can be present in the original actone. We are currently investigating seriously several requirements for the elimination or control of these undesirable solvent components.

Let us now consider the second approach. This involves classification of meal particles without breaking of pigment glands. We are investigating both air classification and liquid classification. Through such means it may be possible to prepare a fraction of the cottonseed flour which approximates in color and quality that of glandless cottonseed flour; not quite white but probably a very light yellow. In regard to air classification--some work is underway and programs have been initiated in this Division. Mrs. Martinez and associates (Oilseed Crops Laboratory) will present a paper describing research in this direction at the forthcoming American Oil Chemists' Society meeting in New Orleans, La. The title of this paper is "Production of Protein Concentrates by Air Classification of Defatted Cottonseed." In such an approach, cottonseed flakes are prepared and then extracted with commercial hexane, under conditions where the pigment glands remain essentially intact. These extracted flakes are then comminuted under conditions to separate the pigment glands from fine meal tissue particles. These fine meal particles are removed by air classification techniques from the coarse fraction containing the pigment glands.

For liquid classification, we are achieving some interesting results. The solvent used is commercial hexane, a nonpolar solvent. It does not rupture the pigment glands.

I have used these processes under development at the SURDD, New Orleans, and the corresponding cottonseed flour product to illustrate that through technology and engineering it is possible to upgrade cottonseed flour so that it can find wider use in foods, particularly in many developing countries. We believe that these processes can be developed to produce these high protein food grade flours from cottonseed at a competitive cost with food flour from other oilseeds.

One cannot expect the cottonseed industry in foreign countries, as well as that of the United States, to jump in and adopt such processing approaches as I presented this morning. Many problems need solution, such as listed earlier. There are two other important factors. One is that the cottonseed industry is relatively unfamiliar with many of the requirements that food industries face, and the other that the cottonseed industry is geared to cotton. How well the U. S. cottonseed industry knows this.

I believe, however, that in the years ahead, the world's ever-increasing need for protein foods will quickly vitalize the cottonseed industry to learn how to process high grade flour from the seed.

In conclusion, cottonseed is potentially a good source for a flour for human nutrition.

FOURTH SESSION: L. A. Goldblatt, Southern Utilization Research and Development Division, Chairman

FOOD FORMULATION POSSIBILITIES FOR MAJOR SOUTHERN AGRICULTURAL PRODUCTS: COTTONSEED, RICE, PEANUT FLOUR, AND SWEETPOTATOES

by
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Cottonseed has the greatest possibilities and the state of its development has progressed to the point that major breakthroughs to successful use in food products is near. Only 15 to 20 percent of the return to the cotton grower comes from the cottonseed. Of this seed portion, about half the return comes from the oil content. Cottonseed oil is well established in the food field because of its remarkable suitability for all-purpose use in shortening, margarine, salad dressings, and in deep-fat frying. Hydrogenated cottonseed oil constitutes the shortening ingredient in many ready mixes of baking items. The quality of soybean oil has been improved by refining processes; the price differential between the two oils has shrunk to only 1 to 3 cents per pound, but still in favor of cottonseed oil. Both soy and cottonseed oil are polyunsaturated and are used in compositions featuring this quality.

A few years ago SURDD developed a process of making a cocoa butter substitute from cottonseed oil. At that time cocoa butter was selling for $1. 25 per pound. Since then the price has dropped so that there is less incentive to make such a substitute at present. Also, SURDD developed acetoglycerides which are in commercial use, but these can be made from any of several vegetable oil fractions, some of which are priced lower than cottonseed oil.

Cottonseed flour, as we know it today, has the disadvantage of poor color and with past history of being suitable only for feed-stuffs. With improvement of color in edible quality flour, cottonseed can replace some of the present uses for soy on a competitive basis. In pointing up the possibilities of its well-to-do neighbor--soybean flour--many of the properties and, therefore, the uses are similar. Only about 3 percent of the protein derived from soybeans in the United States goes into edible applications, and soy production has not yet reached its limitations. We produce 70 percent of the world's crop and consume only about 40 percent. The rest is exported in one form or another. This suggests the possibility of export of cottonseed.

Edible cottonseed flour has two useful values for food formulations: (1) Nutrition and (2) functional properties. In the United States we have no protein shortage yet, but as meat and dairy products become more expensive, there will be a gradual shift to consumption of cheaper vegetable protein of high quality such as that obtained from cottonseed. Because of its more ready solubility, soy protein is considered to be more adaptable to the spinning process used in making simulated meat products, but cottonseed protein may be equally adaptable for some of the other methods of making texturized protein products being used by some commercial companies. We may predict that in the future more vegetable proteins will be used directly for human consumption at the expense of feeding high protein supplements to produce animal proteins.

Soy protein products command a higher price for their functional properties in food--as emulsifiers and stabilizers and for their water-holding capacity. Whenever you can beat air into a product or add water you are more sure of a profit. Unfortunately, we know little of the desirable functional properties of cottonseed protein in foodstuffs. Considering the simplest form--edible flour, we know it has water binding properties, but we also know from preliminary experiments that cottonseed flour adversely affects the volume of yeast breads. The same was true in initial tests with soy flour, but further experiments showed how it could be minimized by increasing the oxidation of the dough until now a small amount of soy is a recognized ingredient in some breads in this country. Use is made at present of the water holding property of edible cottonseed flour in cookie dough where maintaining a uniform size is desired. In the continuous dough process for bread, not as much dry skim milk can be used as in the yeast process (in fact there is less dry skim milk available for use). Edible cottonseed flour might replace part or all of the milk powder. Cottonseed flour might also be used in doughnuts and pancakes. In all probability, what will be desired is the highest protein content flour that can be obtained at lowest cost. This will likely be a 60 to 75 percent protein flour. If cottonseed flour can be used instead of soy, it would compete with 50 percent protein edible soy flour at 7 to 8 cents per pound. Soy protein concentrates of 70 percent are permitted in sausages at a level up to 3-1/2 percent. These are made by a wet process. Assuming equal effectiveness on the basis of protein content, the 75 percent protein cottonseed concentrate would cost about 15 cents per pound compared with 20 to 22 cents per pound for 70 percent soy protein concentrate.

Cottonseed flour and concentrates could likely be used in meat products such as sausages, frankfurters, slicing meats, and meat loaves, but will need approval by USDA Meat Inspection Division (MID). One pound of isolated soy protein at 35 cents per pound can be substituted in frankfurters for 5 pounds of chuck meat at $0. 50 per pound, a cost savings of $2. 15 cents. Regulations of MID limit the quantity that can be used in this product to 2 percent. Cottonseed protein might have a price advantage over soy, but meatpackers are not interested in undertaking on their own the necessary research to obtain approval because of the lack of an established source of supply in unlimited quantities at an existing competitive price. European countries may not be so fussy about inclusion of cottonseed in such meat products.

In formula foods cottonseed is being used in weaning gruels in some developing countries. The first such products was Incaparina, developed by the Institute of Nutrition of Central America and Panama at Guatemala City, commonly known as INCAP. The present formula No. 9A consists of 38 percent cottonseed flour. Difficulty is encountered in obtaining a supply of cottonseed flour sufficiently low in gossypol. The standard has been raised to 0. 06 percent gossypol in order to increase the quantity available for such use. Quaker Oats is distributing such a product in Venezuela. A similar product has been developed in Peru (Peruvita) and is distributed by Nestle.

Under the Food for Peace program 150 million pounds of a formula food for weaning gruel with the name Blended Food Product will be purchased this year. This is commonly referred to as CSM and consists of 68-percent cornmeal, 25-percent soy flour, and 5-percent dry skim milk. There has been some talk of including cottonseed flour in such a formulation, but until a high quality edible cottonseed flour is commercially available, there does not seem to be much opportunity in this direction. Acetone-hexane-water extracted cottonseed flour would meet food nutrition requirements in such a mixture perhaps by juggling the formula a bit.

In the absence of specific studies on functional properties of cottonseed flour in foods, we must extrapolate on similar properties of soy to conjecture on possibilities. Edible cottonseed flour may not be any cheaper than soy on a per pound basis, but it will sell on what it will do per dollar cost. If 10 percent more is required of a product that costs 90 percent as much, there is no competitive advantage.

In discussing food formulations, possible use of cottonseed flour in pet foods, especially dog foods, should not be overlooked. Dogs require a high protein diet and soybean grits are used in present formulations.

Bread. It is estimated that 90 percent of the bread produced in England contains soy flour. Both full fat and extracted flour are used.[1] The effects claimed are that it: (1) Gives softness to the crumb; (2) bleaches white flour pigments; (3) decreases staling; (4) improves flavor; (5) gives a better bloom and brighter crust color, and (6) reduces production cost. This last factor is probably the overwhelming reason. Bread standards are set close to the maximum amount of water that can be incorporated into a dough without danger of possible failure with weak flours. Soy protein and presumably cottonseed protein, as well, will absorb a larger percent of water. For every pound of soy protein added, 1-1/2 to 2 pounds of additional water may be used. The protein holds the shape of the dough and prolongs the characteristics of freshness in the bread on the grocer's shelf so that there is less returned goods. Obviously, the protein must be soluble to accomplish this benefit and cottonseed flour may need special processing to maximize this property. Only research can tell the tale.

When soy is used in high extraction flours, the level of potassium bromate must be raised to get maximum volume in the loaf from yeast breads. Similar tests need to be done with cottonseed flour prepared in different ways.

[1] Food Mfr. Ingredient Survey, pp. 11, 12, and 15, Jan. 1967.

In a single series of tests with bromate addition performed by our Human Nutrition Division of ARS, it was found that hexane-extracted flour gave better volume than AHW extracted flour. No followup has been conducted to determine the cause or adjust the formula. We know that heat-treated milk performs better in bread. Do we have to give cottonseed flour a special treatment to increase its performance? Extensive research is needed on the baking quality of cottonseed flour.

The cooking-extrusion-expansion method adds a new dimension to food processing techniques. We are all familiar with expanded corn snack marketed under various trade names. These are made by various patented devices that rely upon friction generated by rubbing particles of cornmeal grits together under high pressure and then suddenly releasing this pressure. Starch is gelatinized by the heat and the escaping steam on release of pressure creates many tiny bubbles giving a porous structure to the discharged extrudate which is instantly cooled by the evaporating water and sets in this form. In the manufacture of dog food, a continuous pressure cooker is used which, because of the short time exposure to high temperature, does a better job of preserving nutritive value of cereal proteins than the breakfast food people do in toasting. Essentially, what you have is a compression screw turning inside a steam-jacketed cylinder, a feed hopper at one end, and a die at the other. In our experimental equipment, steam pressures up to 110 p. s. i. can be used. The input product can be brought up to a temperature of 320° F., within 60 seconds, rapidly cooled to 212°, and quickly brought down to room temperature.

We are hoping to be able to reduce the free gossypol in cereal-cottonseed mixtures to a permissible level without unduly damaging the epsilon amino-free lysine. Our first efforts have shown that by extruding a mixture containing 25 percent cottonseed meal and 75 percent corn grits, the free gossypol was reduced from minus to 0.01 percent.

We also plan to extrude cereal-seed protein combinations which, when ground or crushed, will, because of the gelatinized condition of the starch, disperse readily in cold water to form nutritious beverages, or we may make discreet particles by forming or slicing.

I would be remiss if I did not mention the virtues of gossypol-free cottonseed. It is only by such a forward stride that the food manfacturing industry will become widely interested in edible cottonseed. Its high quality gives cottonseed needed prestige to raise it from the feed trough. Within a few years we hope there will be available varieties of gossypol-free seed yielding fiber comparable in quantity and quality to that of established varieties. The slight increase in return for this cottonseed will be a plus factor to persuade the grower to plant glandless varieties. Demand for such seed will extend around the world in cotton growing areas, many of which cannot grow soy.

Herbert Gregg of Hale County, Tex., (population density 42 per square mile) released his Gregg 25V seed, not as a glandless variety, but as being wilt tolerant, which it is. It is somewhat ironical that the first commercial production of gossypol-free cottonseed was in a sparsely settled area far removed from the population explosion and by a grower who had heard little of world food problems. Here is an opportunity not only to sell edible cottonseed flour overseas but to export our scientific knowledge of plant breeding to produce better varieties in developing countries.

Rice. We have recently prepared a snack food by extruding rice grits prepared from brewer's rice and coating it with cheese flavor. The extruded rice has a more uniform porous texture than the product made from corn. The extrudate can be crushed to make a flake or ground to make gelatinized rice flour. We have also popped rice paddy, screened out the hulls, and ground the popped rice to a flour. This flour is gelatinized and has a very low bulk density. Both of these flours desperse readily in cold water. When mixed with oilseed flours, a stable suspension is formed that enables oilseed flour milklike beverages to flow through the nipple of a baby bottle.

Rice flour based milklike products may find more ready acceptance in countries where rice is a stable article of diet and where corn or other cereals may not be as well known. Some Asian people use a rice gruel for weaning infants. This is made by overcooking ordinary rice in an excess of water and mashing the grains.

U. S. consumption of rice has increased in the past few years. This is attributed to rice being made available in more readily accepted forms as parboiled, precooked, and in combinations with other ingredients to make convenience meals. Some of these latter items may find their way into the export market.

Peanut flour. There is no flavor or aesthetic problem in acceptance of peanut products. There is the matter of cost because in other countries peanuts are cheaper than in the United States. If an aesthetically acceptable and high quality product can be made from peanut press cake, then there is the possibility of exporting this for use in bakery products or beverages.

Sweetpotatoes. Next to rice, sweetpotatoes are consumed by the greatest number of the world's population. They grow around the world in a belt where the heaviest population exists. But, they are generally used during a short season after harvest as developing countries do not have the facilities for holding in sotrage. Our sweetpotato flakes offer the opportunity for extending the season of use and also for manufacture of mixes for sweetpotato pie, or for candy for sale to developed countries, or to the economically fortunate portion of developing countries. Sweetpotato flakes might also be combined with low cost protein products to make somewhat familiar and acceptable products for protein short populations.

MARKET RESEARCH FOR EXPORT

by
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A convenient approach to the assigned subject is to: (1) Briefly review some market research concepts; (2) outline some of the main differences between domestic and foreign trade; and (3) review typical research on this matter with emphasis on research in the South. The technical definition of some terms are relaxed in this paper to enable a broad survey of the subject.

Market Research Concepts

To illustrate the importance of market research my family has consumed a package of each of 10 different kinds of Post's breakfast cereals during the past 2 months. Post, a division of General Foods, spends about $100 million annually for advertising. By returning the 10 boxtops to the company, my sons, ages 7 and 9, will obtain a free toy spy kit. This and similar advertising campaigns are very effective in forcing retailers to carry brands and to devote sufficient shelf space to them to sell the quantities desired.

Do General Foods, and others, first produce the goods and then endeavor to convince the public that these are the kind of goods and in the amount they desire? Or, do they first endeavor to discover by research what is desired? In most cases the answer is probably some combination of the two approaches because consumers are unable to decide exactly what they want in advance and yet certain basic preferences can be discovered.

A basic device used by business firms to reach a wise decision on this critical matter in the face of such uncertainty is the budget. In fact, the first step in preparing an overall budget for a firm is the development of a sales budget. Salesmen are required to submit detailed estimates of what they believe they can sell during the budget period. Past records of the firm and related information are also examined and general economic trends studied. Finally, a sales estimate for each product is reached and quotas assigned--but only after considering what salesmen compensation, storage activity, advertising, credit policies, and other expenditures will be necessary to secure these sales at the prices decided upon. The sales budget of a firm suggests several areas of market research activity; there are others.

Marketing is generally considered to include all those economic activities that take place after the item is produced. It includes wholesaling, retailing, and the manufacturer's sales organization. For agriculture, the definition would also include processors of agricultural products and the wholesaling, transportation, and other activities taking place between the farm and the first processor. Actually the creation of any economic goods or service is production. This includes marketing, but as a practical matter that part of it described above is generally separated from production in the minds of nearly everyone.

Market research involves inquiry into the institutions and functions of marketing. It is done by economists, engineers, psychologists, and many other disciplines. Many times it is a team approach. Advertising may be the relatively important factor to be studied in one case and storage in another. In still other cases finance, purchasing, selling, transportation, standardization, risks, information, or some combination of these factors may be the important question.

Perhaps because the field is so broad there is much difference of opinion as to the most appropriate techniques, methods, and objectives. Like other scientific inquiries about questions brought before it; however, certain general procedures are involved. Briefly they are: (1) The formulation of pertinent questions about the subject of the research; (2) the collection of facts about the questions; (3) analysis of these facts; and (4) the presentation of conclusions or a proposed plan of action based upon the analysis.

Among the more usual questions to which market research addresses itself are: What is the market for a new product? What storage is needed and where should it be located? What are the most efficient transportation arrangements? What is the income, age, education, and other characteristics of the ultimate consumers of the product? Which of alternative advertising campaigns will be most effective? What are the costs and margins at various steps in the marketing process? At what price will customers purchase what the producer would like to sell? Under what conditions would it be profitable to establish a new marketing operation? What laws and regulations must be considered? There are many such questions and the answers obtained for any one of them may be valid for only a short time. Nevertheless, it is through such procedures that General Motors, for example, attempts to assess what consumers want and will pay for before its manufacture, if certain promotional efforts are made.

Certainly farmers have the same kind of vital interest in market research about the products they grow. But the amount of market research they can do individually is very limited. Through their organizations, however, and through those large firms via which their products move before they are finally consumed, a considerable amount of marketing research is done. In addition, the State Agricultural Experiment Stations and the United States Department of Agriculture maintain pertinent marketing research programs. It is this public phase of marketing research as related to exports that we are most interested in today.

Foreign Trade

In the March 13, 1967, issue of Barrons appeared a story about the Commodity Credit Corporation's (CCC) Credit Export Sales Program. The story centered around Bank of Egypt Letters of Credit accepted by the CCC amounting to some $70 million after this bank had already defaulted on a note due the United States Export-Import Bank for $2 million. The Export-Import Bank is a Federal lending agency created to promote trade between countries and for other reasons. Previously the Intra Bank of Beirut, Lebanon, left the CCC holding $21 million in Letters of Credit having at best unknown value.

This is not to criticize the CCC or whoever is responsible for the applicable marketing research. I am certain that I could not have done as well on the job they had to do. Worse, we in Louisiana have done very little in marketing research for export that might help in this and other problems. Mr. Barlow yesterday pointed out very well how important exports are to us and I feel sure some such research is forthcoming. Soybeans, rice, cotton, and sugar are all important crops in Louisiana. Each are already important in foreign trade and others are potentially important.

In many respects export trade is similar to domestic trade. Unlike domestic trade, however, the export trade usually deals with marked differences in languages, monetary standards, trade barriers, transportation arrangements, consumer preferences, legal systems, and governmental attitudes toward business.

To carry on export trade there must be a method by which a country's currency, for example, can be valued in terms of that of every other country. Gold has ceased to perform this function in a large part. Instead, bills of exchange, similar to drafts used in domestic trade, are utilized. These instruments may be drawn in pesos, yen, or other currencies and they are bought and sold readily in a foreign exchange market. If a country--the United States for example--exports much more than it imports, the supply of such instruments drawn on dollars will be scarce and their value in terms of other currencies rises in the foreign exchange markets. The results is that other countries are discouraged from importing United States products until the supply of these instruments comes back into balance with the supply of such instruments drawn on other currencies. Conversely, if the United States should export less than it imports the supply of dollars would be plentiful and importers would be encouraged to buy more American products.

For a number of reasons all countries impose barriers to international trade. These take the form of tariffs, quotas, embargoes, and others on the import side. Export control and other devices are used on the export side. These barriers violate the so-called law of comparative advantage, of course, and the countries involved suffer certain economic consequences. But these barriers are effective means of accomplishing certain goals. For example, tariffs on luxuries may be set higher than those applying to necessities. Important government revenues may also be derived from what amounts to taxes on imports or exports.

For the less economically diversified countries, the problem of foreign trade is very serious. Thailand, for example, earns more than half of its foreign exchange by rice exports. Perhaps because this factor is so important to that Nation, their government maintains what amounts to a monopoly on all rice exports. Malaya, on the other hand, must spend an important part of its foreign exchange for rice. Its government, therefore, maintains very tight control on rice imports.

There are many kinds of and reasons given for government intervention in foreign trade. Certain activities of European Economic Community are current and important examples. Periodically, it is the question of what the United States should do in regard to Australian beef imports. An editorial in a newspaper only last Monday noted that U. S. textile imports were nearly as large as the current deficit in the balance of payments for the nation. Imports of dairy products are currently worrying some in the dairy industry.

At this time in history the trend is toward more exports of agricultural products by the United States. At the same time there is a trend toward more trade barriers being used both by this country and by others, especially the more developed countries wherein lies the cash markets. Regardless of their economic soundness, these matters are a fact and must be reckoned with in market research for export.

Public Marketing Research in Foreign Trade

A great deal of useful statistical information about the export trade is published by the United Nations and responsible agencies in the United States and other countries. While it is not always in as much detail as desired, researchers have not made as much use of what is available for interpretive analysis as they could. Nevertheless, the number of good analyses made from this and other information is too voluminous to survey here. Instead, I have chosen to review selected research published in the South and other research underway here and elsewhere. The research selected for review is directly aimed at foreign trade. Other market research is no doubt also very useful in this matter.

The Arkansas Agricultural Experiment Station recently published a study on factors affecting the estimated future foreign demand for soybeans. Using regression analysis primarily, they estimated the effects of national per capita income, price, and certain other variables on imports of soybeans and soybean products in certain important cash export markets. A 1-percent rise in per capita income results in as much as a 3-percent increase in soybean imports in some countries. Many of the countries studied were former recipients of our aid programs and have now become good cash markets as noted in other publications. Does it follow that those countries now receiving such aid will become good cash markets for United States agricultural products in the future? Many people believe so.

A publication of the Louisiana Agricultural Experiment Station in 1954 outlined the importance of maintaining a large volume of export trade between the United States and other countries and to the agriculture of the South. In the report were several suggestions for maintaining and stimulating exports from the United States, one of which included the notion of supplying foreign consumers with what they wanted rather than what we had been producing.

In 1959, the Texas Agricultural Experiment Station began an evaluation of the results of market development work in Italy for USDA's Foreign Agricultural Service. Ten specific factors were found to be of importance to the increased sale of U. S. farm commodities in foreign countries. These factors constitute guidelines that can be used to evaluate, in advance, the success of promotional efforts abroad.

The Tennessee Station has published certain foreign market research under its India Agricultural Program. Other stations with similar programs have done likewise.

Most of the current market research for export centers around potential markets and competition for important U. S. agricultural products. Many of these are on a country by country or region by region basis. Some are attempting to assess the role of Public Law 480 and other programs and policies on the economy of the importing countries. Others are assessing the role of exports and related policies on the domestic economy, particularly agriculture, including business firms closely related to it. The North Central Regional Grain Marketing Research Committee, for example, is studying the impact of export price subsidies, international pricing arrangements, and other factors on the United States' share of the world market for grains, including soybeans.

There are more than 50 active public research projects dealing directly with foreign trade in the United States. Only one of these, a Pennsylvania project, deals directly with the import side of foreign trade.

Much of the public market research in foreign trade is done by the United States Department of Agriculture. Nearly all the remainder is done by the agricultural experiment stations with Federal support. In the South there are only two such projects financed altogether with State funds. The USDA contracts some research with citizens of foreign countries.

Texas and North Carolina are by far the two most active states in market research for export in the South at the present.

In my opinion the more than 50 active public research projects dealing with foreign trade are attempting to come to grips with a very important matter. If I have any criticism of them, it is one which I have been guilty of many times. This concerns the tendency to outline more in a research project than can be accomplished with the available resources. As a result, too many important assumptions are made in order to complete the research undertaken. Too frequently, those that would use the research take the results as they are emphasized in a summary and pay too little attention to the underlying assumptions.

In this paper a number of, but far from all, the concepts of marketing research and of foreign trade were briefly examined. Each have many important implications other than the few examples used to illustrate them.

Export markets for agricultural products, although already important, are expanding rapidly. The considerable research effort now being devoted to this subject is a rather recent development and is small relative to that devoted to the domestic trade. Under these circumstances such research is likely to be among the most productive.

FOOD SUPPLEMENTS TO IMPROVE NUTRITIVE QUALITY AND CONSUMER ACCEPTANCE

by
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As Dr. Goldblatt pointed out, there are several built-in advantages and disadvantages of being the last speaker on the program. It so happens I have one disadvantage in that my topic was built in to several of the other papers. I have therefore discarded my formal talk and am going to discuss the topics listed in the paper I have presented to you (see attachment). I prepared this list for two purposes: (1) I wanted you to have a list that you could refer to as considerations which are necessary before preparing a food supplement or before you can supplement foods. I prepared this form also because it is one of my devious means of distributing advertising for recognition of the LSU Food Science and Technology Department. You will notice that the title is "Food Supplements To Improve Nutritive Quality and Consumer Acceptance." This title is in error and should be "Food Supplementation for Supplementation of Food." This is a very common mistake, and I am pointing it out because I think you should be careful about attempting to define these topics.

I have divided the definitions into: Food supplements, supplementation of foods, and food additives, including irradiation and chemicals.

Food supplement.--A food supplement is as the name implies, a supplement of nutrients which is formulated to be taken separately or independently from foods. There are a number of advantages and disadvantages to food supplements. One major disadvantage is that the people who take food supplements feel that because they have an adequate intake of certain essential vitamins and, let's say minerals, certain amino acids and other ingredients that are built into these supplements, it gives them an excuse for not consuming adequate caloric intake and other nutrients that probably are still unknown. So there are advantages and disadvantages to all of these. An important advantage is that today many children and older folks do not eat adequately balanced diets because they prefer certain foods to others. They, therefore, do not obtain adequate nutrition. There are advantages for them to take supplements. Consider supplementation of foods for just a minute and bear in mind that I have never lost sight of the fact that this conference was designed primarily to review Southern agricultural crops for preparing certain foods or supplementing certain foods for distribution. However, there are many other problems I think we have overlooked somewhat, and I am going to make a few comments about them. You must remember first that all supplementation should be designed to bring inadequate levels up to a required level.

One serious problem we have, both in food supplements and supplementation of food, is that we don't know where to stop. We know where to start because we think in terms of minimum daily requirements; but, one of the big problems that we run into, especially with food supplements, is that if company "A" puts out a product and it has a certain quantity of vitamin A, the various B's, C, and D vitamins, another company, in order to compete, will go ahead and manufacture another supplement and merely increase the intake or increase the quantity. A third company will come along and increase the quantity even greater, and so what happens? The first company has to turn around and increase their contents because most of these products may be distributed from door to door. You're dealing with a lot of salesmen who will say to the people, "If you buy this, you're getting a smaller quantity for your money." What we need is a good educational program, and I think we ought to carry this over into the Latin American countries. Food supplements and supplemented foods alone are not adequate. We must educate these people--especially the family--on what good nutrition is comprised of and how they should use the supplements after they receive them. Another factor we often overlook is that if their level is not marginal, but is highly deficient, then we're dealing with a medical case. I think they should receive adequate medical attention along with some of these supplements. I am pointing out that dietary supplements alone or supplementation of food isn't the whole answer if these people already have severe deficiencies. We should always bear in mind that most of these people should be considered from the medical angle, that is, the presence of organic disorders, as well as from the nutrition standpoint. Of course, I realize that most of these problems are usually related.

The serious problem of increasing levels to a high degree is reflected in our learning more and more about the toxicology of various food supplements and about the various vitamins, minerals, amino acids, and such. You have noticed during the last 10 or 15 years that we have developed many techniques whereby we can now analyze for certain constituents that we didn't know how to analyze for in the past. They may be present in relatively small quantities, but we never gave them any consideration. You remember that 30 or 40 years ago you ate food but knew very little about vitamins and amino acids. Now we know how to analyze for them and we are familiar with their reactions. Think in terms of insecticidal residues, trace minerals, alkaloids, and other materials for which we are not developing sensitive tests. Here on the Gulf Coast, to give you an example of one of our commodities--in dealing with shellfish we had the problem of people being concerned about bacterial contamination. If microbial tests did not measure up to certain standards, it served as a means of eliminating the food as being a health hazard. While we investigated methods to eliminate and prevent most of these health hazards from developing, we were suddenly confronted with insecticidal residues. We have learned how to analyze for traces of residues so that if we don't discard the food bacteriologically we may discard it on the residue basis. Now we expand our knowledge about trace elements and the toxicology of trace elements, so we must start analyzing foods for trace elements. If the quantity in a certain element in a certain food is too high we may eliminate the food on that basis. Soon we will analyze for very small quantities of alkaloids, other chemicals, poisons, and materials that are actually drugs by definition of a drug.

As we perfect food analysis, we must eliminate most of our foods because we know now that every food contains some material which is usually present in an undesirable quantity, therefore eliminating that material as a food. So, in planning in terms of food supplements and supplementation of foods, bear in mind that a particular food to be supplemented may contain some undesirable compound(s). Authorities of foreign countries may accuse you and say, "Look you gave us this food and we found it contains a certain trace or a high quantity of ingredient which is dangerous," when you didn't even know it was present in the food in the first place. I mention this because it is a problem presently confronting food science. We must be concerned about it and I present it as a little food for thought in that area.

Food additives. --All of you know what a food additive is, but let's just point out that you are dealing with two kinds--the intentional additive which you use for a specific purpose and the incidental additive, such as a trace of insecticidal residue, which is present as a means of processing, production, and packaging.

An additive is, according to official definition, a compound or group of compounds and it should not be present as a chance contaminant; but, if you will examine some of our present definitions, radiation of food is now considered to be a food additive. While it is contrary to the definition, it is a food additive. Why is radiation of food a food additive? You use energy from heat to cook food. This is not considered an additive. You barbecue. You subject food to other forms of energy. These are not additives. It is an additive merely because Congress said it is an additive even though it is contrary to the general regulation. I am pointing this out to you because I am attempting to show how these problems get out of order and how it takes years for us to put them back into their proper perspective.

These are the type of problems that confront us when we are involved in supplementing foods for distribution to foreign countries. One big advantage of supplementation of foods over food supplement is that you seldom alter or modify the original taste of the food and, therefore, a person can enjoy the food and still have the advantages of that food. Whereas, with the food supplement you don't know whether a person is taking a supplement or being administered a drug.

The problem with food supplements is that when levels for a new factor are not established at present, a food supplement may cease to be a supplement and may become a drug. I have an example. It is a sample of AD for prenatal use. It is a very excellent product by Upjohn and it contains a list of AD, as the name implies, fluoride and several B complex vitamins. At the bottom of the box there is a statement that says "This product must be sold only upon the prescription of a physician." I have here two pages from the recent Montgomery Ward & Co. catalog. You can find the same products in the Sears Roebuck & Co. catalog who lists the very identical item. It can be purchased through mail order with no consideration whatsoever either by your physician or by any health authorities. The reason I mention this is that is poses another problem to us in that when we supplement foods for distribution to other countries, we should examine their health recommendations by their various medical associations and make sure the supplements that we are adding are recognized as being satisfactory to these various groups. Here in agriculture, probably we are doing more to safeguard the health of people. We should strive to obtain our fair share of the recognition because we can recall the basic fact that it is usually inadequate nutrition that leads to such things as infection and organic disorders. Inadequate nutrition and undesirable environmental changes results in a need for medical attention. A physician is trained more in corrective measures and surgery, but not as thoroughly in nutrition as most of the people in agriculture. Again, I will restate that I do not think we are receiving sufficient credit for the general health and welfare that we contribute to mankind by being in agriculture. I think we should demand this recognition. So much for that.

I might mention the various methods employed for nutrition improvement. I noticed throughout this conference we consistently used the word fortified when we meant enriched and we used the word enriched when we meant fortified. Bear in mind that these three words are defined as follows: When you enrich a food, you are adding nutrients such as the three B vitamins to white flour (tables 1 and 2). If you restore, you are getting total replacement of the substances that have been damaged during the process. If you fortify, then and only then, are you adding one or more nutrients that are not normally present in a particular food. It might surprise you to know that during World War II the U. S. Army asked the distilling industry to investigate the possibility of adding vitamins to whiskey. The reason for this request to modify a product which we were distributing around the world was that troops were doing a considerable amount of drinking in many areas and, therefore, getting improper nutrition. They were developing thiamine, riboflavin, and niacin deficiencies. As far back as the early 1940's we considered fortifying such a product as whiskey, but of course you couldn't do it today because it would be adulteration of the product. I thought it would be interesting to mention this because it would have supplied essential vitamins to troops developing deficiencies because of inadequate nutrition. The high alcohol intake decreased their appetites.

There is no need to discuss the loss in cultivation, processing, storage, transportation, and preparation. All of you are familiar with the various metabolic changes and the various biochemical mechanisms involved in a vitamin loss, protein breakdown, etc., through ordinary enzymatic reactions, oxidation, etc., which doesn't warrant any special discussion. It does remind me to review another nutrition problem on supplementation.

Supplemented foods.--If we give a person a food supplement, he still requires an adequate intake of foods. With a supplement, we are insuring that the individual is getting an adequate intake of specific nutrients. In spite of any kind of supplement, which we might administer or distribute, we must also recognize that none of them is beneficial for good nutrition without proper environmental conditions. This is another factor which is overlooked quite often in good nutrition. You cannot overlook environmental factors. For example, what advantage is adequate nutrition if you kill a person by air pollution? That may or may not be a good example, but I am pointing out the importance of environment. Proper exercise is important as is proper work, play, and rest. You can give a child excellent nutrition, but if that child doesn't have a decent bed to sleep in and obtain adequate rest at night and proper exercise and play during the day, you are still going to be confronted with a health problem. Age groups and special diets must be discussed. We cannot prepare and we would be severely criticized if we prepared one product or one supplement which we felt would be satisfactory for all age groups. This is why there has to be special considerations for any kind of food supplement, as supplementation of food for pediatrics and diets for special organic disorders. This is where we have an opportunity in certain countries with widespread diseases that are common to that country. We can prepare a diet designed to cure that specific disease or disorder and, therefore, do that country a great service. It was mentioned during this program that this has happened in certain instances and proved to be very beneficial.

Supplementation of specific foods need not be gone into. Nutritional deficiencies in individuals and individual requirements--this is a topic we cannot cast aside. You may have sons and daughters in junior high and high school. You can't give your daughter and son the same food. It is almost impossible. Your son will eat anything and everything you put on the table, and he will consume satisfactory quantities to assure adequate nutrition. What happens to your daughter when she gets into high school? She says, "Mother, I am too heavy" or something to that effect. She doesn't want to eat. She cuts down on her diet, and it is human nature for her to probably be more interested in her figure than adequate nutrition. Whether we like it or not, these are the problems we are confronted with, not only here, but also abroad. I know it is impossible for us to solve everybody's problems; but as I said all I am doing at present is pointing out to you that we are confronted with problems like this and they have to be considered sooner or later.

Under nutritional deficiencies, I have listed disease, age, sex, pregnancy, allergies, sensitivity, and in geriatrics, the feeding of older folks. Then too, weight control drugs. A lot of people take weight control drugs, lose their appetite, and get insufficient diets. As these other countries advance in nutrition, they are probably going to develop problems from such preparations because in their country such drug products are readily available where we limit the sale of certain kinds of products they do not. They have many drugs available to them that are as much a hazard in that country as adequate nutrition. It would be a sad affair, if we thought that we could overcome some of their inadequate nutrition, only to find out that some of their problems are from drug use, abuse, and otherwise.

Advertising. --The control of most sales is through company advertising and some of the larger companies can put quite a lot of money into this medium. There are two types of advertising as I see it--individual advertising and mass advertising. By individual advertising, I am talking about a person who may be selling something from door to door and coming into your home trying to sell you a food supplement, a supplemented food, or a health food. Let's not forget health foods. You might be surprised to know how many health foods are available today even in some of the Latin American countries. So these can be problems, and there are many societies who will use them and consider them to be effective. Individual foods and food products--these are publicized on radio, television, and in newspapers.

Food supplements are your major problem, because you might visit a physician and

Table 1. --Comparison of three B vitamins and iron in wheat flour (by the pound)

Wheat flour	Thiamine	Riboflavin	Niacin	Iron
	Mg.	Mg.	Mg.	Mg.
Unenriched	0.28	0.21	4.1	3.6
Enriched (all-purpose)	2.0-2.5	1.2-1.5	16.-20.0	13.0-16.5
Whole wheat	2.49	.54	19.7	15.0

Table 2. --Comparison of three B vitamins and iron in wheat bread (pound loaves)

Wheat bread	Thiamine	Riboflavin	Niacin	Iron
	Mg.	Mg.	Mg.	Mg.
Unenriched	0.31	0.39	5.0	3.2
Enriched [1]	1.1-1.8	0.7-1.6	10.0-15.0	8.0-12.5
Whole wheat	1.17	1.03	12.9	10.4

[1] Enriched bread may also furnish as an optional ingredient added vitamin D in such quantity that each pound of the finished bread will contain not less than 150 United States Pharmacopeia (U.S.P.) units and not more than 750 U.S.P. units of vitamin D.

he might diagnose that you have a vitamin deficiency. Again, let's point out that people who have deficiencies usually have marginal deficiencies. If you have a deficiency that's greater than a marginal deficiency, the physician will determine if you need a food supplement or therapy.

Advertising food supplements. --One of the strangest cases I have ever heard of in the history of food science is one involving Nutrilite Products, Inc., food supplement manufacturers in Buena Park, Calif., and the Food and Drug Administration (FDA). Nutrilite was a company selling excellent food supplements during the forties. You might be surprised to find out that we sell between $800 million and $1 billion worth of vitamin products today, which is a tremendous amount of money. Getting back to this case and what happened--sales were made on a private basis where an individual would go from door to door and attempt to promote or sell a product for $20.50. This was a vitamin supplement and a good product. All the vitamins were from reputable manufacturers, but the advertising in the accompanying box may have been controversial. This product was made in one of the most beautiful plants possible. No money was spared whatsoever in maintaining the best sanitation and hiring very competent scientists, pharmacists and others to manufacture the product. Salesmen would go from door to door and they were not scientifically trained individuals. These salesmen would say that the product would cure almost anything from cancer to rheumatism. FDA filed an injunction against Nutrilite in about 1949 and the case went through the courts for several years. At the end of that time, neither side apparently was agreeable. Nutrilite finally agreed to an injunction that they would refrain from making such claims. Actually you couldn't say the claims were false or true because they were adding quite a bit of vegetable concentrates to their product and you don't know what unidentified factors might have been present in such a product and what pharmalogical activity might have existed. Anyway, the company agreed to this. In other words, the FDA was saying, "We want you to stop," and the company would say, "We are willing to stop." But FDA went one step further. They asked the court to give them permission to examine the literature before it was put into the box and before the product was distributed. The company agreed and the judge agreed. Everybody was satisfied. Now the company could advertise that they marketed the only food supplement whose literature was approved by the Federal Food and Drug Administration. Can you imagine what that was worth? They didn't have to tell people that the product cured anything. When such a comment was made, it was the greatest stamp of approval possible. I feel that it was well worth mentioning this case because I am showing you that in some of these instances you can use a decision to your advantage or disadvantage according to your interpretation and requirements.

The same situation could happen to us on some products we may be distributing in foreign countries. A number of speakers pointed out that you can give people products that they need but if they don't like the taste they accuse you of passing off trash. I don't mean to be pessimistic, but I am merely suggesting that we protect ourselves because we are developing good products and, therefore we should demand recognition at the time of distribution.

I have one or two more comments before I close. What is the future of food supplements and food additives? There is no doubt in my mind that the future of supplementation is absolutely unlimited. As a good scientist, I think we will develop products that may be synthetic or prepared from natural sources. When you say synthetic you are really thinking in terms of products originally derived from natural sources and those modified or altered. We will develop a synthetic product which is complete and varied in caloric intake and vitamins, mineral, amino acids, and such, which does not present any built-in health hazards through impurities that could be present if natural constituents were in the product. We will be able to take such a product, vary the texture and flavor, and convert it into almost any type of synthetic food desired. Because of this, I think the future in food science is absolutely unlimited. Remember we are dealing with the largest industry in the world and dealing with the one industry without which one cannot survive. We should confidently inform the public and keep them aware of the importance of food and food science and keep them aware of our efforts to assist starving people in the world. I don't care what we do anywhere in the world. We must attempt to educate all family units in good nutrition and that good health is something that starts at birth and continues throughout life. We must encourage the family to learn how to handle children of all ages--all the way up through having the younger generation take care of the older generation when they need geriatric treatment.

Attachment 1 for
FOOD SUPPLEMENTS TO IMPROVE NUTRITIVE QUALITY AND CONSUMER ACCEPTANCE

Food supplementation has been a constant problem since its inception, because of numerous misconceptions by both food manufacturers and consumers. This discussion concerns some of these misunderstandings and how they might be corrected.

Definitions:
- Food supplements
- Supplementation of foods
- Food additives, including irradiation and fluoridation, etc.

Methods employed for nutrient improvement:
- Enriched - as adding 3 B vitamins to white flour
- Restored - total replacement
- Fortified - adding 1 or more nutrients not normally present in that food

Loss of nutrients in foods and food products:
- Cultivation
- Processing
- Storage
- Transportation
- Preparation

Age groups and special diets:
- Pediatrics
- Diets for special organic disorders
- Supplementation of specific foods
- Nutritional deficiencies in individuals
  - Individual requirements
  - Disease
  - Age, sex, pregnancy, etc.
  - Allergy and sensitivity
- Geriatrics

Methods of advertising:
- Individual foods and food products
- Food supplements
- Nutritive products
- Health foods

Food and drug laws

The future of food supplements and food additives

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